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OF THE

Mineralogical Society.

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THE MINERALOGICAL SOCIETY

Mineralogical Society.

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EXCERPT MINUTES OF COUNCIL MEETING.

Held in the Apartments of the Geological Society, November 11th, 1890.

R. H. Scott, Esq., M.A., F.R.S., President, in the Chair.

Mr. S. R. Adcock and Mr. W. Rich, both of Rio Tinto, and Mr. F. G. Shaw were elected Members of the Society.

The resignations of Mr. J. E. Drew and Mr. G. F. Martyn, both Associatesof the Society, were announced.

The following dates were selected for the Meetings to be held during the year 1891:—January 27, April 14, June 16, November 10 (Anniversary).

ANNIVERSARY MEETING.

Held in the Apartments of the Geological Society, November 11th, 1890.

R. H. Scott, Esq., M.A., F.R.S., President, in the Chair.

The following Report of Council was read and approved:—

REPORT.

The Balance Sheet for the year ending December 31, 1889, which was issued with No. 42 of the Journal, showed that the state of finances was not unsatisfactory. The Assets (exclusive of the Stock of Publications and the Library) show an excess over Liabilities of £220 8s. 5d.: in this connection it may be mentioned that the number of Members who have compounded for their Annual Subscription is 30.

During the session 1889-90 five ordinary Members have been elected. On the other hand, the Society has to regret the loss by death of one Member, Lord de Blaquière, who for many years has acted as one of the Trustees for the invested funds of the Society, and of one Associate, Mr. E. F. Morton; one Member and three Associates have resigned, and the name of one Member has been removed from the list for non-payment of subscriptions: it may be added that four Members and one Associate are without known address.

The Council has great pleasure in reporting that Professo N. S. Maskelyne, M.P., F.R.S., has consented to act as Trustee in place of Lord de Blaquière, deceased.

Four meetings have been held, all in London, and (by kin permission) in the Apartments of the Geological Society, Bur lington House.

Though only two numbers of the Journal have been issue during the session, they exceed in number of pages the thre numbers issued in the preceding year. No. 41, which appeare in April, contained papers on the Hemimorphism of Stephanite an the Crystalline Form of Kaolinite, by Mr. Miers; on artificiall crystallised Zinc Oxide, by Messrs. Cundall and Hutchinson ; o Zinc Sulphide, Stephanite and Polybasite, by Mr. Prior ; but wa chiefly remarkable for the Index to the Mineralogical and Petro graphical Papers of 1887, for which the Society is indebted t Mr. Miers. This Index, like those of which it is a continuation is obviously the result of much patient industry on the part o its author, and cannot fail to be of great service to those wh are engaged in mineralogical research. No. 42, which appeare in August, contained a short, but interesting account of a visit t the Calcite Quarry in Iceland, by Mr. Hoskyns-Abrahall; th description of a new mineral species, Sanguinite, by Mr. Miers notes on a hard form of Serpentine, or Pseudo-jade, fro Afghanistan, by Major-General McMahon ; and a discussion o the Relations between the Gliding-planes and Solution-planes o Augite, by Professor Judd. The greater part of the number i occupied by Mr. Fletcher's paper relative to the Mexican Meteo rites. This paper, taken in conjunction with one in the precedin number, gives as complete an account of the history and distri bution of the Mexican Meteorites as can be got from the examina tion of the specimens and literature at present available for student in this country. The Council begs leave to report tha the Library of the Society has been removed to Cambridge, an that any of the books may be borrowed by Members on applic tion to the Librarian, Professor Lewis.

The Council still looks foward to a more frequent issue of th Journal, but the present income of the Society is not such as warrant any increase of the expenditure.

The following were elected Officers and Council for the ensuing year :—

President. R. H. Scott, M.A., F.R.S.

Vice-Presidents. Rev. Prof. S. Haughton, M.D., F.R.S.
Hugo Müller, Ph.D., F.R.S.

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R. H. Solly, M.A., F.G.S.
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Prof. Grenville Cole, F.G.S.
T. W. Danby, M.A., F.G.S.
John Horne, F.R.S.E., F.G.S.
Frank Rutley, F.G.S.

Mr. B. Kitto, F.G.S., and Mr. F. W. Rudler, F.G.S., were re-elected Editors.

Votes of thanks were passed to the Geological Society for the use of its apartments for the Meeting, and to the retiring Members of the Council (Prof. Church, Mr. Hall, Maj.-Gen. McMahon and Mr. J. S. Thomson).

The following papers were read :—

"Twins of Marcasite in regular disposition upon Cubes of Pyrites," by O. Trechmann, Ph.D., F.C.S. (page 209.)

"Notes on Cassiterite," by R. H. Solly, M.A., F.G.S. (page 199.)

"Note on Ullmannite," by H. A. Miers, M.A., F.G.S. (page 211.)

EXCERPT MINUTES OF COUNCIL MEETING.

Held in the Apartments of the Geological Society, January 27th, 18

R. H. Scott, Esq., M.A., F.R.S., President, in the Chair.

The audited Balance Sheet for the year 1890 was submitted and orde to be issued with the next number of the Journal (page xiii.).

M. J. Gorham, M.R.C.S., of Tonbridge, was elected a Member of Society.

Mr. H. A. Miers was elected a Member of the Editing Committee place of the retiring Member, Mr. T. Davies).

GENERAL MEETING.

Held in the Apartments of the Geological Society, January 27th, 189

R. H. Scott, Esq., M.A., F.R.S., President, in the Chair.

The following papers were read :—

"On an Eclogite from Loch Duich." By J. J. H. Teall, M.A., F.I (page 217.)

"On a Micro-granite containing Riebeckite from Ailsa Craig." By same. (page 219.)

"On Occurrences of Riebeckite in Britain." By Prof. Grenville A Cole, F.G.S. (page 222.)

"On a Rapid Method for the accurate Recognition of Sulphi Arsenides, Antimonides, and Double Compounds of these Elements Metals." By C. A. Burghardt, Ph.D. (page 227.)

"On a System for constructing Crystal Forms by the plaiting of t Zones." By J. Gorham, M.R.C.S. (page 235.)

Specimens of minerals and crystal models were exhibited in illustra of the above papers.

RECEIPTS.

	£	s.	d.
Balance from year 1889	12	5	1
Subscriptions:—(1) in advance	4	9	0
,, (2) current	72	2	6
,, (3) in arrear	7	18	6
Entrance Fees and Compositions	3	3	0
Sale of Journal	18	11	1
Repayment for Authors' extra copies	15	19	6
Dividends on Stock	6	18	3
Illustration paid for by Mr. Hutchinson	0	12	6
	£141	19	5

PAYMENTS.

	£	s.	d.
Printing and Stationery	102	11	11
Illustrations (1890)	7	9	0
Editorial and Clerical Expenses (1890)		Nil	
Purchase of Journal	1	10	0
Insurance of Stock of Publications	1	5	0
Postages, Parcels, &c.	12	4	9
Investments	6	18	3
Fees in connection with Change of Trustee	1	15	8
Carriage of Library to Cambridge	0	19	6
Attendance at Meetings, 1890	1	17	0
Balance	5	8	4
	£141	19	5

Examined and compared with the vouchers and found correct. (Signed)

BENEDICT KITTO,
F. W. RUDLER, } *Auditors.*

1891.

LIABILITIES.

	£	s.	d.
Williams & Strahan, Printing, &c.	55	10	11
Received in advance (1) Subscriptions	4	9	0
,, ,, (2) Sale of Journal	0	1	11
Excess of Assets over Liabilities	220	0	2
	£280	2	0

Number of Life Members is 30.

ASSETS.

	£	s.	d.
Subscriptions for 1888-90 unpaid	5	5	0
Stock in 2¾ per Cent. £258 12s. 7d. at 95¾	247	12	9
Interest on Stock (unpaid)	1	13	5
Sale of Journal:—(1) due from the Publishers	17	18	0
,, (2) due on Office Account	2	4	6
Balance as above	5	8	4
	£280	2	0

The Stock of Publications and the Library are not included in the above assets.

(Signed)

L. FLETCHER,

General Secretary.

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MINERALOGICAL SOCIETY.

No. 43. MARCH, 1891. Vol. IX.

Cassiterite, "Sparable Tin," from Cornwall.

By R. H. Solly, M.A., F.G.S.

[Read November 11th, 1890.]

URING the last few years some fresh specimens of Sparable Tin have been raised from various mines in Cornwall; a description of this iety may therefore be of interest to the Society.

The value of this description of the new finds will perhaps be increased combining with it an account of the specimens of Sparable Tin from erent mines now to be found in our museums and private collections. rough the kindness of those gentlemen who own or have charge of these ections, I have been enabled to see and examine many of the interesting cimens which they contain.

The name "Sparable Tin" is peculiar to Cornwall, and has been given his variety of Cassiterite on account of its so-called resemblance to the rable nail of the cobbler.[1]

[1] Sparable may be the corruption of Sparrow-bill, so-called from its shape; *O.E.* rwa, a sparrow, literally 'a flutterer'; or the meaning of sparable nail may be ply that which spars or rivets, since *A.S.* 'sparriam' means to fasten or rivet.

The crystals are always sharply pointed, having the ditetragonal pyram
z {321} largely developed together with an elongated striated prism.

In 1814 Mr. William Phillips published in the *Transactions of t*
Geological Society a most valuable and interesting monograph on Oxyd
Tin, with eleven large plates of drawings of the different forms of Tin, a
the accuracy of his work is proved by the fact that the angle which
found for the element of Cassiterite is accepted to-day.

On page 340 he says, "If it should hereafter more generally appe
that some modifications of the primitive crystal of this substance a
principally the production of particular districts, as I am led to suspe
will be the case, might not an investigation of the nature and peculiariti
of the veins and of the countries through which they pass tend to thr
some light on the circumstances or laws by which the several modificatio
are produced: may not these circumstances be supposed in some degr
to depend on the purity of the substance entering into combination wi
it? The Bohemian oxyd has not hitherto been observed to assume
great a diversity of crystalline forms as the Cornish, which, by the analy
of Klaproth already noticed, appears to be by far the most pure."

To this suggestion we are able to add to-day, that the slower the grow
the greater is the modification of the form, and that minute impuriti
when not chemically combined have apparently no effect upon the cryst
line structure, though when an isomorphous interchange of elements tak
place a marked change is observed in the crystallographic element—but
the question, "What is the law which governs the different habits
modifications of crystals?" we can add nothing at the present time;
that we can do is to describe the modes of occurrence and the associat
minerals for crystals of very similar combination, and leave the physici
of the future to deduce a law by the aid of such material. With this e
in view I have brought together descriptions of the various specimens
the Sparable Tin of Cornwall.

Literature.

1814. Phillips.	Trans. Geol. Soc. p. 336.
1822. Haüy.	Traité de Minéralogie.
1823. Phillips.	Mineralogy, third Edition, p. 250.
1852. Miller.	Phillips' Mineralogy, p. 235.
1856. Gadolin.	Verh. Russ. Min. Ges. p. 184.
1855. Nordenskiöld.	Pogg. Ann. 101, p. 637.
1864. Hessenberg.	Mineralogische Notizen, VI. p. 18.

LITERATURE—*Continued.*

877. Becke. Min. Mitth. Vol. I. p. 243.
882. Collins. Min. Mag. Vol. IV. p. 1.
889. Busz. Zeits. f. Kryst. XV. p. 623.

TABLE OF FORMS.

iter.	Symbol.	Author.	Locality.	Remarks.
	001	Phillips	Cornwall	Very rare on Sparable Tin
	100	,,	,,	Very often present ,,
	110	,,	,,	Always present ,,
	210	,,	,,	Not common ,,
	320	,,	,,	Very often present ,,
	430	,,	,,	Very common ,,
	870	Busz	Huel Nancy	Very narrow ,,
	14 13 0	Gadolin	Pitkaranta	Not observed ,,
	101	Phillips	Cornwall	Always narrow ,,
	501	,,	,,	Not observed ,,
	114	Gadolin	Pitkaranta	,, ,,
	335	Phillips	Cornwall	,, ,,
	223	Gadolin (s_1)	Pitkaranta	,, ,,
	111	Phillips	Cornwall	Always present ,,
	552	,,	,,	Very often present, very narrow
p	551	Gadolin	Pitkaranta	Not observed on Sparable Tin
	661	Solly	Cornwall	Sometimes well developed ,,
	771	Gadolin	Pitkaranta	Not observed ,,
	12 12 1	Solly	Carn Brea and Tregurtha	Well developed ,,
	18 18 1	,,	Huel Fanny	Largely developed ,,
	120 120 1	,,	Cornwall	Sometimes well developed ,,
	313	Phillips	Bohemia	Not observed ,,
	321	,,	Cornwall	Characteristic form ,,
	432	Solly	Maudlin mine	Narrow and rare ,,
	752	Becke	Huel Nancy	,, ,, ,,
	13 11 2	Solly	Mary Hutchins	Rare and narrow ,,
	761	Hessenberg	Wheal Harris?	Not observed? ,,
	871	Busz	Cornwall	,, ? ,,
	21 14 18	Gadolin	Pitkaranta	,, ,,
	19 16 7	,,	,,	,, ,,
	742	,,	,,	,, ,,
	17 13 6	,,	,,	,, ,,
	942	,,	,,	,, ,,
	3 11 2	,,	,,	,, ,,
	?	Phillips	Cornwall	?

The above list of forms, with the names of the authors who first rved them, will be found to differ from Becke's list, as he has ignored lips' work.

iller has left out f_3, f_2 and k_2 of Phillips as forms not observed by him, ugh, if we accept his angles, f_3 would be the plane η (771) observed by olin on crystals from Pitkaranta and Cornwall;

Phillips.	Gadolin.
$f_3\ m = 8°54'$.	$\eta\ m = 8°32'$ calculated.

f_2 might be the n (661) observed by me on many crystals ;

Phillips.	Solly.
$f_2\ m = 10°40'$.	$n\ m = 9°56\frac{1}{2}'$ calculated.

From his figure 175, this should have the same indices as Miller face i, but $i\ m = 22°49'$.

k_2 only appears in the third edition of Phillips' *Mineralogy*, and fro his figure it should have the indices (28 14 3), as it lies in the zon [210, 001] and [$\bar{1}$10, 771] ; but the angles $k_2\ s = 43°40'$ and $k_2\ m$ 8°55′ are not those of (28 14 3).

Some of the Cornish crystals have minute planes lying either in t zone [430, 321] or [110, 321], but they are rounded or too dull to gi any reliable measurements.

The planes $v\ u\ u_1\ u_2\ u_3$ observed by Gadolin on crystals from Pitkaran are omitted by Nordenskiöld, and I have not found them on the Corni crystals.

Becke in his list of forms has given i (552), but in his stereograph projection has placed it at the intersection of the zones [100,321] [110,111 which would give to the plane the indices (221), a form not yet observe

In the zone [110,111] it will be noticed that the indices of the plan of the form $\{h\ h\ k\}$ observed on Sparable Tin are (661) (12 12 1) (18 18 (120 120 1), that is to say h is a multiple of 6.

The face (120 120 1) is often largely developed, and extends into t prism zone, being only inclined at 30′ to that zone.

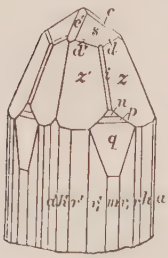

Fig. 1.

Fig. 1 exhibits a combined view of all the plan except c, ψ, ν, θ observed on crystals of Sparab Tin with a characteristic development.

Hemimorphism.

Is Cassiterite hemimorphic ?

Rutile, which is isomorphous with Cassiterite, sometimes hemimorphically developed.

The more or less transparent crystals often ha a dark crystal growth in the centre, the form which is decidedly hemimorphic. See Fig. 2.

I hope to be able to show that it is so from the other varieties Cassiterite in a future paper.

Twins.

There is only one law, namely, the twin axis is normal to a face of the rm {101}, the twin plane and face of composition being the same; the stals are sometimes juxtaposition twins often repeated on the same face, penetration twins consisting of two or more crystals twinned about ferent faces of the form {101}, or simple penetration twins. The last de of twinning is rare: I have only observed it on crystals from the lcoath district, see Fig. 3; two Sparable Tin crystals having the face

Fig. 2.

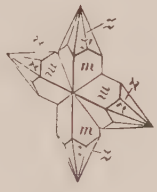

Fig. 3.

composition the twin plane are fairly common in some mines, but arable Tin differs from other forms of Cassiterite in being nearly always mple.

Aggregations.

The mode of aggregation is very similar to that seen in crystals of rmaline. A number of crystals are grown together very nearly rallel to their axis of tetragonal symmetry. This want of parallelism is received by the unequal angle between the *s* planes, which varies as much 30′ in an apparently simple crystal. The prism planes also are seldom rallel.

Cleavage.

Miller gives *a* and *m*, not very distinct; *e*, traces. I have found that stals of Sparable Tin often cleave with great facility parallel to only e of the *m* planes. This points to *m* being a face of union as well as a avage plane, and may be accounted for by aggregation.

Optical Characters.

Double refraction positive.

Refractive indices for red light:—

$$\omega = 1{\cdot}9793 \qquad \epsilon = 2{\cdot}079$$

Very slightly dichroic.

Hardness.

The hardness for the massive brown and fibrous variety is only 6, wh
that of the brilliant black crystals is 7.

Specific Gravity.

The specific gravity varies a good deal.

Black crystals from Tipuani	...	7·021	(Forbes)
Colourless crystals from Tipuani	...	6·832	,,
Honey-yellow crystals from Oruro	...	6·704	,,
Very pure crystals from Carabuco	...	6·4	,,
Black Sparable Tin from Dolcoath	...	6·92	(Solly)

Chemical Composition.

Pure Cassiterite is not known. Dr. E. Ludwig found $SnO_2 = 98°·74$
$SiO_2 = 0·19$ $Fe_2O_3 = 0·12$ $CaO = 0·41$ in a crystal from Schlackenwa
all other analyses show a small percentage of Ta, Ti, Mn, Si and F
this is probably due, as Dr. Ludwig thinks, to imperfect analysis a
separation of impurities.

Elements.

The element adduced by Miller and agreeing with Phillips's angle h
been repeatedly obtained from different crystals, and is therefore adopt
in calculating the following angles:—

001, 101 = 38°55′2″ $\quad a : c = 1 : 0·67247$

ah	=	26°34′	zc	=	67°35′	$zz_,$	=	20°54′	$z,z_{,,}$	=	61°4
ar	=	33°41′	tc	=	35°20′	$tt_,$	=	29°58′	$t,t_{,,}$	=	21°4
$ar_,$	=	36°52′	dc	=	59°15′	$dd_,$	=	13°58′	$d,d_{,,}$	=	59°5
al	=	41°11′	νc	=	70°55′	$\nu\nu_,$	=	17°53′	$\nu,\nu_{,,}$	=	66°3
ak	=	42°52′	θc	=	80°5′	$\theta\theta_,$	=	9°23′	$\theta,\theta_{,,}$	=	78°2
am	=	45°	ξc	=	80°50′	$\xi\xi_,$	=	8°21′	$\xi,\xi_{,,}$	=	79°5
			εc	=	82°2′	$\varepsilon\varepsilon_,$	=	9°31′	$\varepsilon,\varepsilon_{,,}$	=	81°2

$m\psi$	=	0°30′	md	=	31°42′	$m\varepsilon$	=	8°5
mq	=	3°20′	mt	=	58°41′	$m\xi$	=	10°1
mp	=	5°	$ss_,$	=	58°18′	$m\theta$	=	11°
$m\eta$	=	8°32′	$ss_{,,}$	=	87°8′	$m\nu$	=	21°1
mn	=	9°56′	nz	=	16°32′	mz	=	25°
$m5p.$	=	11°52′	pz	=	20°34′	me	=	66°4
mi	=	22°49′	qz	=	22°1′	ce	=	33°5
ms	=	46°26′				cw	=	73°2
$m\sigma$	=	57°37′				as	=	60°5
my	=	60°17′				$at_,$	=	79°2
mx	=	76·37′						

The following description of the various occurrences of Sparable T
begins with the specimens of the Mary Hutchins mine in Devonshire, a
moves westwards to the Land's End.

Description of Specimens.

Mary Hutchins, Plympton, Devon.

Small black to brown crystals with sub-metallic to adamantine lustre, ery much massed together with crystals of quartz. The crystals are ften twinned. Twin plane *e* (101); the *z* planes large; small *s*; well veloped *m*; narrow *a* and *r*; *n* (661) well developed, often rounded. his plane is new, its position was determined by the zones [321, 340] 31, 430].

n m found 9°30′	Calculated 9°56′

Also a very small plane *θ* (13 11 2) lying in zones [010, 661] and 10, 321].

θ m found 10°30′	Calculated 11°

Callington, Cornwall.

The British Museum has a specimen labelled Callington with small light rown crystals with iron-stained pearlspar.

Forms *s z* and prism planes.

Maudlin mine, Lanlivery.

The Penzance Museum possesses a specimen from this mine, and the ritish Museum a number of loose crystals.

The crystals on the Penzance specimen have the forms *z* and *s* equally veloped, prism long, *m* large and rough, narrow *r*, *a* small and bright, arrow *e* and very narrow *i*. A new plane *d* (432) lying in zones 21, 111] [010, 231].

d s found 16°—17°	Calculated 16°54′
d z_1 found 14°—15°	Calculated 14°13′

The following minerals have been found in this mine: chlorite, chalcedony, chalybite, covelline, cronstedtite, fluor, garnet, jasper, melanterite, ispickel, opal, pyrites, pyrrhotine, scheelite, and wolfram.

St. Austell District.—Polgooth mine.

Minute crystals in compact chlorite.

z and *m* well developed, small *e*; associated with calcite, compact and mi-transparent. The other minerals found in the mine are amethyst, lomite, erythrine, pyrites, smaltine, and copper pyrites.

Garrigan Stream Works, St. Mewan.

These crystals are described by Phillips as being about the size of a mmon quill and exhibiting the faces *m z* large, small *s e*, and *c* small and re.

Redruth District.—Huel Fanny.

Phillips has described these crystals. The Penzance Museum possesses a specimen. The crystals are of a light brown colour and very minute. The form q (18 18 1) is largely developed, sometimes very brilliant, giving good reflections but more often dull and rounded. s and z small, narrow i, prism well developed, m large, narrow a r_1 and h.

q m found 3° and 3°30′	Calculated 3°20′

The crystals were found in a shallow part of a copper vein, with red ruthite and wolfram, sometimes imbedded in copper pyrites and coated with chlorite and quartz.

Carn Brea mine, Illogan.

This is a new occurrence. In form and appearance the crystals resemble those from Dolcoath, but are much more modified. The faces z and r large, small s, narrow r, and very narrow r_1.

One crystal is very interesting, as a new face p (12 12 1) is largely developed, being equal in size to the z planes. The angles obtained were very good.

z z_1 found 20°54′	Calculated 20°54′
m p found 4°58′	Calculated 5°0′

The crystals are associated with chlorite and quartz, calcite and brown oxide of iron.

Camborne District.—Dolcoath mine.

The crystals are often very fine, of a jet black colour shading into dark brown with adamantine lustre.

The oldest specimen I have seen is one in the late Sir W. W. Smyth's collection found in 1859. Mr. J. M. Williams, of Caer-hays, Cornwall has a specimen which was raised in 1861, and is associated with limpid fluor and chlorite.

About 1878 a number of fine specimens were raised from the 314 fathom level. Notable specimens are those belonging to Mr. C. C. Ross at Carne the Penzance Museum, and also the British Museum.

Since 1884 some fine specimens similar in habit have been raised from the 260 fathom level. The Jermyn Street Museum and Cambridge University have specimens.

The matrix is invariably chlorite with quartz; I have never observed any tourmaline on the specimens, though Collins has found much acicular schorl in the tin stones which he described in the *Min. Journ.*, Vol. IV

p. 11; but these specimens were taken from the levels where no Sparable Tin has been found.

The forms are simple, z large, small s, well developed prism, m large, narrow r_1. The crystals are sometimes doubly terminated, often twinned, or sometimes consisting of four twinned crystals (Fig. 3).

Huel Harriett.

(This is a Sett adjoining Dolcoath on the South.)

Mr. C. C. Ross possesses a very fine specimen from this mine. The crystals are jet black with adamantine lustre. The forms are: z large, small s, prism deeply striated, r_1 large, narrow m and a. Hessenberg has described crystals from *Wheal Harris* (probably identical with this mine), on which he observed the new face ξ (761), but he says it is always deeply striated and curved, rarely giving good reflections.

The crystals are dark brown to black, banded in colour, associated with transparent fluor spar with a matrix of chlorite.

Huel Grenville.

The British Museum has a specimen. The crystals are on quartz with white talc. Forms s and z and prism plane; colour, dark brown.

Huel Nancy, Camborne.

The only specimen I have seen from this mine is in the Jermyn Street collection. The crystals are dark brown and very brilliant. Prism planes deeply striated, having a number of narrow planes $h\,m\,r_1\,l$. The planes s and z well developed; also a narrow plane ν (752) lying in zone $m\,z$ which had been observed by Becke on a Cornish crystal, locality unknown. The crystals are on chloritic schist with quartz and chlorite.

Gwinear District.—Wheal Tremayne.

These specimens are fairly numerous. The matrix is "peach" or crystallised chlorite and quartz. The crystals are of a light brown colour with good lustre, often closely aggregated together. Forms observed: z well developed, small s, narrow i, well developed n, prism well developed, n and r. The centre of the crystals is dark, giving the form of three crystals one upon the other.

St. Agnes District.

The British Museum has a specimen from St. Agnes district on chlorite, with quartz, fluor and copper pyrites. It is probably from Huel Park. Forms s and z, narrow, with prism planes; fine lustre; colour dark brown.

Helstone.—Great Wheal Vor.

Nearly all collections contain specimens from this locality. Some are jet-black and polysynthetically grown together, others brown and often highly modified. The matrix is killas associated with chlorite, sometimes with very small limpid crystals of apatite with the forms $(10\bar{1})$ (201) (111). Blende, copper pyrites, mispickel, pyrites, and pearl spar have been found with the tin stone.

The black crystals in the Ross collection have the forms $s\ z\ r_1\ m\ l$, narrow i, polysynthetically grown together with chlorite. The brown crystals associated with apatite are very like the Tremayne crystals, having the same crystallographic and optical characters. The Jermyn Street Museum has a specimen from Metal Shaft raised in 1868.

Quartzose veinstone on massive tin stone.

Tregurtha Down mine, Marazion.

The first specimens were obtained from the shallow workings in 1864, but during 1889 well crystallised specimens have been raised from the 95 fathom level.

They resemble in habit and appearance those from Carn Brea. The forms $s\ z$ well developed, large r_1, small m, very bright p and narrow i.

The crystals are associated with quartz, chlorite, and small well developed crystals of albite, and they are often coated with impure kaolin.

Wheal Owles, St. Just.

Black isolated twinned group of crystals. Forms $s\ z$, narrow $i\ m$ and r. These crystals were given to me by Richard Boyns, Esq., of Wheal Owles.

Land's End.

Phillips describes some loose crystals "from the Land's End." Forms $s\ z$ and rounded $(h\ h\ k)$ largely developed.

It may be remarked from the above descriptions that Sparable Tin is always found in close proximity to an elvan; also that chlorite is always present, while tourmaline and topaz are nearly always absent. The only occurrence of apatite associated with Sparable Tin that I have seen is at Wheal Vor.

Twins of Marcasite in regular disposition upon Cubes of Pyrites.

By C. O. Trechmann, Ph.D., F.G.S.

[Read November 11th, 1890.]

THE subject of this note derives interest less from its novelty than from the beautiful manner in which the intergrowth is exemplified in Nature. As Sadebeck[1] has shown, the intergrowth of marcasite and pyrites takes place according to two laws.

(1) The vertical axis of marcasite is parallel with a principal axis of pyrites; one of the two other principal axes of the latter being parallel with the combination edge *m* (110) ∞P : *c* (001) 0*P* of the former; or, in other words, the vertical and one lateral axis (*ab*) of marcasite coincide with two principal axes of pyrites.

(2) The vertical axis of marcasite is parallel with a principal axis of pyrites; the brachydiagonal axis is parallel with a diagonal axis of pyrites.

The first law appears to be the more general, and Sadebeck describes intergrowths where cubes of pyrites are disposed on marcasite, and also where twins of marcasite are disposed upon the cubical faces of pyrites, the twin planes of the former being parallel with the three faces of the cube. (See his Fig. 6, Pl. X.)

The present instance seems to be a more perfect development of the one observed by Sadebeck on crystals from Freiberg; it occurs on a specimen from Bredlar, near Brilon, in Westphalia, consisting of red iron ore upon the drusy surface of which marcasite crystals, together with a lesser number of cubes of pyrites, are dispersed.

The faces of the cubes of pyrites are deeply striated and curved by an indeterminable pentagonal dodecahedron, and the solid angles are occasionally replaced by minute octahedral faces. The marcasite crystals exhibit the forms :—

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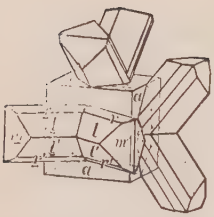
[1] *Ueber die Krystallisation des Markasits und seine regelmässigen Verwachsungen mit Eisenkies, von A. Sadebeck, Ann. d. Phys. u. Chem. Erg. Bd.* 8, 625, 1878 (*Abstract : Zeitschr. f. Kryst.* 3, 626, 1879).



m	110	∞P
l	101	$\breve{P}\infty$
r	104	$\frac{1}{4}\breve{P}\infty$

and are frequently twinned according to the law: twin plane and composition face m (110) ∞P: forming contact twins. All the faces are very much curved and horizontally striated, and are not adapted for exact measurement. The form r, which gradually curves into l, was determined by approximate measurement,

$$r\ r'\ (\text{over } c) = 34°19'\ \text{calc. } 33°0'$$

The disposition of the marcasite crystals upon the cubes of pyrites is such that each face of the cube carries a twin of marcasite by the above law of twinning, and according to Sadebeck's first law of intergrowth, in such a manner that the twin plane is perpendicular to the face of the cube and parallel with the striations upon its surface; thus, the outer prism faces (m) of each marcasite twin are parallel with the adjoining cubical faces, which are striated in the same direction as the prism faces, and the three composition faces of the twins are perpendicular to one another and correspond with the principal axial planes of the cube.

The accompanying figure, in parallel projection, is drawn as closely as possible from nature, and exhibits the marcasite twins, all of the same size, upon the three visible faces of the cube. The form r (104) $\frac{1}{4}\breve{P}\infty$ is however replaced in the drawing by the more frequently occurring form (103) $\frac{1}{3}\breve{P}\infty$.

The Tetartohedrism of Ullmannite.

By H. A. Miers, M.A.

[Read November 11th, 1890.]

ALTHOUGH all the modes of hemihedrism possible in the cubic system have been found to occur among minerals, no mineral belonging to that system has yet been proved to be tetartohedral like sodium chlorate, and the nitrates of barium, strontium and lead.

There has, however, been some evidence in favour of the tetartohedral character of Ullmannite since the examination of the crystals from Lölling in Carinthia, and those from Sarrabus in Sardinia. The former were found by Zepharovich[1] to be distinctly tetrahedral in form and habit, the latter were found by Klein[2] to be distinctly pyritohedral. Zepharovich found the specific gravity of the Lölling Ullmannite to be 6·72, while Klein found that of the Sardinian crystals to be 6·803—6·883, and for this reason it was at first thought that the two occurrences might be different modifications of the antimono-sulphide of nickel; there was also considerable discrepancy between the two analyses.

But subsequently Klein and Jannasch[3] re-examined the Ullmannite from both localities, and found them to be identical both in composition and specific gravity. This necessitates one of two conclusions: either NiSbS is dimorphous, occurring both in a tetrahedral and also in a pyritohedral modification, or the mineral is tetartohedral. The latter is the more natural supposition; but it is not easy to understand why the crystals should be so distinctly tetrahedral in one locality and pyritohedral in the other, without combining the two characters in either.

I have had no opportunity of examining crystals from Lölling, but the description of Zepharovich makes it perfectly clear that they are not only tetrahedral but are also interpenetrating twins in which the mode of

[1] *Lotos* (1870), 20, p. 4.
[2] *Neues Jahrbuch*, 1883 (1), p. 180.
[3] *Neues Jahrbuch*, 1887 (2), p. 169.

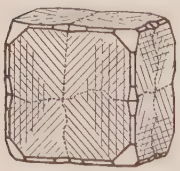
twinning restores a holohedral aspect to the tetrahedron as in the case of diamond.

Now, it is evident that this complementary twinning about the dodecahedral axes will simulate the holohedral character both in the tetrahedron and the pyritohedron; the latter is exemplified by the interpenetrating twins of iron pyrites.

It seemed probable, therefore, that a more careful examination might reveal traces of tetartohedrism and of twinning on the crystals from Sarrabus.

Here, as in the case of other opaque minerals, the surface striæ afford the most available clue to the compound nature of the crystals. In his first description of the cubes of Ullmannite from Sardinia, Klein mentions a well-marked striation similar to that of pyrites. In the second description he mentions that there is also to be seen here and there a striation parallel to the octahedron, and this was also observed by Seligmann.

The Sardinian specimens in the British Museum show the above characters, but the octahedral or diagonal striations on the cube faces exhibit the following peculiarities:—The faces are broken up into a number of distinct fields, upon some of which the striæ are parallel to one diagonal alone, while upon the remainder they are parallel to the other diagonal. It is evident then that each of these fields is a portion of a single crystal of at most tetrahedral symmetry, and that these crystals are twinned together about the dodecahedral axes.



The external appearance of the Sardinian cubes is represented, somewhat idealised, in the adjoining figure, which sufficiently explains the structure of the crystals. The diagonal striæ are always perpendicular to the edge of combination with the tetrahedron. The junction of the individuals is sometimes irregular, but is more usually parallel to the cube faces, so that the crystals appear to be built up of rectangular plates. At the points of junction the cube edges have a re-entrant angle formed by small striated faces of a triakis-octahedron, having indices near {27.27.1}, inclined to the tetrahedron at an angle of 37°—40°; these are often the only faces on the cube edges even when the latter appear to be truncated by the dodecahedron.

Since the pyritohedral striæ upon each cube face are only in one direction and traverse all the individuals, it follows that the crystals are not only tetartohedral and twinned about the dodecahedral axes, but that they consist of enantiomorphous individuals; thus in all respects resembling the

ht and left handed twin crystals of sodium chlorate, in which one ividual of the twin crystals exerts a dextro-rotatory and the other a ro-rotatory action on polarised light. If two identical crystals of lmannite were twinned together, the pyritohedral striæ would be repro-ced parallel to all the edges on each cube face.

The tetartohedrism of Ullmannite does not make it necessary to remove mineral from the group of isomorphous disulphides and arseno-phides to which it is always referred, although so far as is known the mainder are pyritohedral, with the possible exception of gersdorffite and ynite. Dolomite, ilmenite and dioptase are analogous cases.

Becke[1] has suggested that the tetartohedrism of dolomite, which has en proved, both in its crystalline form and elastic properties,[2] to possess wer degree of symmetry than calcite, is due to the lower symmetry of molecule Ca Mg $(CO_3)_2$ as compared with the molecule Ca Ca $(CO_3)_2$. But Ullmannite in its composition offers no such want of symmetry as mpared with cobaltite, gersdorffite or corynite. It would be interesting uld these three minerals also exhibit evidences of tetartohedrism, since ir composition is less symmetrical than that of the disulphides or rsenides. The specimens in the British Museum do not exhibit a artohedral character.

[1] *Min. Mitth.* XI. p. 255.

[2] *W. Voigt. Ann. Phys. Chem.* XL. p. 642.

A Student's Goniometer.

By H. A. Miers, M.A.

(With Plates III., IV., and V.)

[Read October 25th, 1887.]

THIS instrument, which was designed for use in the Crystallographic Laboratory of the City and Guilds of London Institute (Central Institution), is in its simplest form (Plate III.) a strong and inexpensive Wollaston Goniometer. It is, however, constructed in such a way that it may be converted into an instrument of greater precision (Plates IV. V.) by the simple addition of accessory parts to the apparatus of Plate III. without any previous alteration.

L is the graduated disc, and B the milled head by which it is turned; the vernier *v* is not the slender tongue of metal which is usual in such instruments, but is engraved upon a portion of the fixed disc V; and L is kept in continual contact with V by means of a circular steel spring inserted between B and the bearing of the axle. L has an inner lip by means of which it may be clamped by the screw C to the fixed disc V; the fine adjustment may then be effected by the slow motion screw D, which works against a spring and is fixed to V at a convenient angle on the side furthest from the observer.

The bearing of the axle is cast in a single piece with the metal cross piece which supports the disc, and is made longer and more massive than is usual in similar instruments.

The only essentially new feature is to be found in the mounting and adjustment of the mirror; this part of the apparatus is carried by a strong brass tube A firmly screwed to the solid crosspiece. Upon A is a sliding tube E which can be clamped in any position by a split ring and screw shown at *e*; upon E and at right angles to it is fixed the tube F, in which slides a cylinder also clamped by a split ring and screw shown at *f*, but this cylinder has a pin fitting to a slot in F, so that it can only slide without rotation; the mirror is attached to it by the capstan-headed screw H.

will be seen, therefore, that the mirror is capable of adjustment by sliding movements along straight lines perpendicular to each other, ely, along the cylinders A and F, and by two movements of rotation t these lines.

adjust the mirror the screw H is loosened, and the mirror is set llel to the axis of the instrument in the usual way by means of a nt signal and a small plate with parallel faces mounted upon the ometer ; H is then clamped once for all, after which the other move- ts may be employed without disturbing this adjustment ; the mirror for instance be set at any desired inclination by rotating the tube E t A.

ate IV. shows a modification of the same instrument in which the le crystal holder and adjustments of Wollaston are replaced by the complicated centring and adjusting apparatus devised by von Lang. receive this addition the axle of Plate III. is made hollow, so that ng more is required than to remove the crystal adjustment-piece of III. and to pass into the hollow axle a second axle attached to the ad- ment-piece of Plate IV. The latter consists as usual of two traversing s, M N, working at right angles to each other, for centring, and two ut screws working parallel to them for adjustment of an edge.

this instrument the centring movements are not, as is usual, effected slide which travels between straight guides, but the screws M N set notion two plane discs which swing about pivots at m and n, and e in contact with one another.

e motion imparted to the discs by the screws M N is therefore not linear, but a circular motion about m and n as centres. There is or no practical inconvenience in this arrangement, and it is simpler onstruction and stronger than the usual sliding motions between guides. moving pieces are kept in true plane contact by spring nuts which through slots having the form of circular arcs described about m and spectively as centres. Q is the milled head which turns the piece I.

nally, a third modification of the same instrument is shown in e V.

ere the levelling screw at the end of A having been unscrewed, the or is removed and replaced by a strong tube P, provided with two ps x x, which slides on to A in place of E. This tube carries a cope T and collimator W, attached to supports which slide upon site sides of a solid vertical circular arc ; upon this they may be set y desired inclinations by means of screw clamps on their inner sides ;

s s s are adjustment screws, by which the telescope and collimator a brought into the same vertical plane and directed towards the axis of th instrument.

This Goniometer has been constructed by Messrs. Troughton an Simms, of New Charlton, whose circles are, as is well known, divided wi great accuracy.

The instrument of Plates III., IV. may be used with a horizontal s placed in front of a window at a distance greater than 10 feet from th goniometer, as a distant bright signal. Prof. Miller originally recommend the employment of a separate faint signal which is to be seen reflected the mirror, while the bright signal is observed by reflection in the cryst I have found it advisable to use only one bright signal to supply both th image in the mirror and that in the crystal face.

To bring the two images into coincidence it is only necessary introduce before the mirror a small card screen of such a height that can intercept all the light which falls from the slit upon the mirror, b not the light which falls upon the crystal; if the screen is then mov laterally until it cuts off half or more of the image in the mirror, t adjustable image seen in the crystal face may easily be set with accura so as to form an exact prolongation of the remaining portion of the fix image seen in the mirror ; any desired amount of the latter can be cut by moving the card screen.

A still more convenient signal is that recommended by Prof. Mallar a small slit placed at its focus behind a large lens of about 5 inches fo length which stands close to the goniometer and is illuminated by a lam

To fix crystals to the holder nothing is more convenient than a mixtu of beeswax and pitch, which may be fused together in different proportio to form a cement of any desired consistency ; for this purpose a mixt in the proportion of two parts by weight of wax to one of pitch is genera suitable.

On an Eclogite from Loch Duich.

By J. J. H. Teall, M.A., F.R.S., F.G.S.

(By permission of the Director General of the Geological Survey.)

[Read January 27th, 1891.]

HE existence in the British Isles of a rock essentially composed of garnet and omphacite, and answering therefore to Hauy's[1] definition of eclogite, does not appear to have been hitherto recorded.[2]

The following description of such a rock from Totig Ferry, Loch Duich, is therefore of some interest. The specimen was collected by the Director General, who informs me that he believes it to be a part of the Archæan mass which in the region of Loch Alsh and Loch Carron has been thrust bodily from the east over the Torridon sandstone.[3]

The rock is of a dull green colour, and contains numerous reddish-brown garnets. Under the microscope the principal constituents are seen to be garnet and omphacite—a pale green pyroxene without any definite crystalline form. Green hornblende, plagioclase, rutile, iron-ore, quartz, and epidote occur as accessories.

Garnet.—This mineral is of the common almandine-type. It occurs in isomorphic crystals, and as aggregates of more or less rounded grains. Rutile and iron-ores are present in it as inclusions. A narrow zone of hornblende-substance frequently surrounds the garnets, and this is especially the case when omphacite and garnet are not separated by any other mineral. The hornblende-substance also penetrates the garnets along cracks. Irregular patches of epidote are sometimes seen in the interior of the garnets, as if replacing portions of their substance.

Omphacite.—This is a pale-green mineral having the cleavage and optical characters of pyroxene, but without definite crystalline form. It

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[1] *Traité de Minéralogie.* 2nd. ed. Paris, 1882. T. II. p. 456, and T. IV. p. 548.

[2] Prof. Bonney has described a rock essentially composed of garnet and hornblende under the name of hornblende-eclogite. *Quart. Journ. Geol. Soc.* Vol. XXXVI. (1880) p. 106.

[3] The description is based on a specimen (No. 1805) in the collection of the Geological Survey.

is very faintly pleochroic in greenish and yellowish tints. Hornblend and felspar are sometimes intimately intergrown with omphacite. Thi hornblende, as already pointed out, forms a narrow zone separatin garnet and omphacite. It also replaces omphacite more or less in certai parts of the rock. The intergrowths of omphacite and felspar are of micro-pegmatitic character, and in some parts of the slide they play th *rôle* of groundmass. That the ferro-magnesian constituent of thes micro-pegmatitic aggregates is omphacite and not hornblende is proved b the fact that where the aggregates are in contact with omphacite i extinguishes simultaneously with that mineral, and resembles it in a other respects.[1]

Hornblende.—The mode of occurrence of this constituent has bee sufficiently described above. The pleochroism is as follows :

α pale yellowish brown.
β deep rich green.
γ bluish green.

Felspar.—Colourless water-clear felspar, showing one and sometime two sets of twin lamellæ, is present in the rock in small quantity. It mode of occurrence is remarkable. In thin section it appears in smal irregular and isolated patches between the larger constituents. Unde crossed nicols these isolated or apparently isolated patches give uniform extinction over considerable areas. It appears, therefore, that felspar b itself or intergrown with omphacite plays the *rôle* of groundmass in por tions of the rock.

Rutile.—This mineral is present in the form of deep yellowish brow grains and slender yellow prisms. The grains are often associated wit iron ores, which, however, occur very sparingly in the rock. *Quartz* i rare, and probably a secondary product. *Epidote* is also rare. Its mod of occurrence has already been described in speaking of garnet.

[1] Becke describes similar intergrowths of hornblende and felspar in an eclogit from Altenburg. Tscherm. Min. Mitth., Neue Folge, B. IV. p. 318.

On a Micro-granite containing Riebeckite from Ailsa Craig.

By J. J. H. Teall, M.A., F.R.S., F.G.S.

(By permission of the Director General of the Geological Survey.)

[Read January 27th, 1891.]

RIEBECKITE was first described by Sauer[1] in 1888. The type-mineral occurs in granite from Socotra collected by Dr. E. Riebeck.

In the same year Harker[2] identified the peculiar blue hornblende occurring in the quartz-porphyry of Mynydd Mawr with the mineral described by Sauer, and in the following year two fresh localities were given for this mineral by Le Verrier[3] and Lacroix.[4] The last mentioned observer has also shown that crocidolite must be referred to the same group of hornblendes.

The object of this communication is to place on record the occurrence of riebeckite in the so-called syenite of Ailsa Craig, the small island which stands at the entrance to the Firth of Clyde. The following description of this island is taken from the *Memoirs of the Geological Survey* (Explanation of Sheet 7, page 12):—

Ailsa Craig is an oval-shaped island, lying ten miles west from Girvan. Its extreme height is 1,113 feet, its longer (or N. and S.) diameter is about 1,500 yards, and its shorter (or E. and W.) diameter from 1,000 to 1,250 yards. It rises nearly vertically from the sea, on all sides except on the east. There a triangular patch of low shingly ground intervenes between the base of the steep eastern declivity of the island and the shores. The Craig consists of a gray fine-grained syenite, which, on the

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[1] *Ueber Riebeckit, ein neues Glied der Hornbledegruppe. Zeitschr. d. deutsch. Geol. Gesell.* Band XL. (1888), p. 138.

[2] *Additional note on the blue hornblende of Mynydd Mawr. Geol. Mag., Decade* III. Vol. V. (1888), p. 455.

[3] *Sur une venue de granulite à riebeckite de Corse. Comptes Rendus*, CIX. p. 38.

[4] *Sur une roche à amphibole sodique (riebeckite), astrophyllite, pyrochlore, et zircon de Colorado. Comptes Rendus*, CIX. p. 39.

southern and western precipices, shows a system of close, parallel, vertica joints, by which a columnar aspect is given to the rock. Though n Silurian strata are visible here, there is every reason to believe th this syenitic mass rises among rocks of that age, resembling in th respect, as well as to some extent also in petrographical character, som of the crystalline rocks which rise through the Silurian strata of th south of Ayrshire. Dykes of dolerite run in a north-westerly directi through the syenite."

The syenite, which may perhaps be more appropriately termed a micr granite, although the point is not of much importance, is of a ligh greenish gray colour, and fine grained, almost felsitic, in texture. Sma felspars may occasionally be seen, and the surface is spotted wit irregular blotches of a dark blue colour. When examined with a hand lens the main mass of the rock is seen to be finely crystalline, and bot felspar and quartz may be recognised. Nothing definite can be made ou as to the nature of the dark blue patches beyond the fact that they a aggregates of a dark-coloured mineral and the main mass of the rock.

In thin section under the microscope the essential constituents are see to be felspar, quartz and riebeckite. Zircon has been detected in the powd of the rock.

The riebeckite occurs in small extremely irregular patches wedged between the idiomorphic felspars of the groundmass. Several of the small patches usually occur together; and, although apparently detache they are similarly orientated. The mineral therefore forms spongy ophit masses, the inter-spaces being occupied by felspar. Crystalline form not generally recognisable, but cross-sections showing the cleavages hornblende may be seen. The absorption is very great, so that it is no means easy to investigate the optical characters of the mineral. The are best made out in the feather-edges of oblique sections and in slid made from the powdered rock. The mineral is strongly pleochroic greenish or yellowish brown and deep blue tints.

α and β=deep blue.
γ=yellowish or greenish brown.

All that can be definitely ascertained with reference to the extinction that the angle is very small. The fact that the greatest axis of elastici (α) is the one which is most nearly coincident with the vertical axis c be readily observed in the small fragments obtained by breaking up t rock. This is the most characteristic feature of riebeckite, and the o which distinguishes it from all other hornblendes. It is this which mak

eckite, amongst the hornblendes, the equivalent of ægirine, amongst pyroxenes.

The larger felspars, which give a micro-porphyritic character to the , occur in crystals and fragments. Rectangular sections with straight nction are not uncommon, and binary twins may occasionally be erved. The small felspars of the groundmass make up a large portion he rock. They give lath-shaped sections, and, like the larger felspars, either simple individuals or binary twins. In the slides prepared from powder of the rock rhomboidal flakes showing the emergence of a tive bisectrix normal to the flake (M flakes) and giving an extinction of nt 10° in the positive direction have been observed. These facts nt to the conclusion that the felspar is a soda-orthoclase.

The quartz is interstitial or ophitic. It fills the spaces between the morphic felspars.

Only two or three zircons have been observed. They are perfect crystals he simple type showing the forms {110} and {111}.

On Occurrences of Riebeckite in Britain.

By Grenville A. J. Cole, F.G.S.

Professor of Geology in the Royal College of Science, Dublin.

[Read January 27th, 1891.]

In the summer of 1890, in the company of Mr. L. W. Fulcher, I agai visited Mynydd Mawr, on the west of the Snowdon area, in the hop of obtaining specimens of Riebeckite larger than those on which Mr Harker[1] and Professor Bonney[2] based their observations in 1888, whe they independently pointed out the occurrence of this mineral for the firs time in the British Isles. Previous traverses of the dome-shaped mas had shown how uniform in structure and how minutely crystalline th rock of Mynydd Mawr was over all its surface; we accordingly examine the columnar cliffs on the north and west, paying especial attention to th great western hollow, where denudation allows one to stand almost in th centre of the intrusive neck. But even here we were somewhat dis appointed, and our specimens are only slightly coarser in grain than thos studied with such striking results by Professor Bonney.

In section, however, the blue colour of the amphibole is seen in thes new specimens with greater clearness than heretofore. The streak patches formed by the mineral are two to three millimetres across, and i one case, taken from a loose block fallen from the cliff, we have th remains of a single crystal at least two millimetres in length. The axi colours, changing from the characteristic intense black-blue to a rich yellow brown, are particularly striking in these large examples.

Though the groundmass of the "felsite" of Mynydd Mawr has unde gone secondary devitrification, and at one time must have approached th glassy condition so prevalent in Wales among rocks of Bala age, y abundant porphyritic crystals occur in these central masses. Orthoclase predominant, with some quartz, which has in part developed with its prop outlines, as happens in so many rocks intermediate between granite an

[1] "On the Blue Hornblende of Mynydd Mawr." *Geol. Mag.*, 1888, p. 455.

[2] *Mineralogical Magazine*, Vol. VIII., pp. 103 and 169. For analysis of Riebecki see *ibid.* p. 167.

e glassy rhyolites. The quartz granules of the groundmass, in their sociation with the duller felspathic areas, suggest the commencement of micro-pegmatitic structure. Throughout this groundwork of material perfectly differentiated and developed, the patches of soda-amphibole m an appropriate and original constituent. Their mode of occurrence alls the groups of streaky biotite characteristic of the spherulitic and cro-pegmatitic soda-eurites.

The development of all the minerals seems, however, to have been rried, doubtless owing to the comparatively short time during which hly silicated lavas remain fluid. Hence the amphibole, while surnding in places well formed crystals of felspar, and tending to proce an ophitic structure, has been interfered with by the development of rtz and felspar in the glassy groundmass round it, and has thus only ely arrived at any recognisable crystalline form. But for the inclus of idiomorphic orthoclase, which run into the amphibole from the rrounding groundmass, it might have been urged that these ophitic es were relics of large crystals which had been eaten into on all sides the glass.

a prior consolidation, however, when the porphyritic crystals were duced, similar amphibole arose under conditions that would have ren-ed the rock granitic. For we find in one of the thin sections an resting "glomeroporphyritic"[1] group, consisting of quartz, ortho-se, and the richly coloured riebeckite. The material is unfortunately fficient to afford evidence of the order of succession of these minerals the granitic consolidation. The quartz of this group has been cor-ed by the groundmass, and the riebeckite seems also to have suffered. The evidence of these central specimens, if I read it rightly, is that rock of Mynydd Mawr reached its present position, in what seems to a volcanic neck more than a mile in diameter, as a soda-glass con-ning porphyritic crystals and groups of crystals; these were attacked long as the mass remained fluid, but they suffered less than is com-n in actual lava flows. While consolidating as a pitchstone on its rgins, where it abuts against the altered slates, the mass in its more tral parts tended to become micro-pegmatitic, after the manner of the ite of Cader Idris, but without spherulitic aggregation. At this stage riebeckite developed, filling up interstices and forming in many places tinuous ophitic crystals. The cause of its crystallisation at so late a ge is probably to be found in its easy fusibility, to which attention has

[1] Judd, *Quart. Journ. Geol. Soc.* Vol. XLII. (1886), p. 71.

been called by Mr. Harker.[1] With 35 per cent. or so of iron oxides, 10 per cent. of alkalies, and a striking deficiency of magnesia, riebeckite would remain far longer than ordinary amphiboles in the condition of a molten glass.

That Prof. Bonney has foreseen some of these conclusions, despite his view that the mineral is of secondary origin in the great mass of the rock, is clear from the concluding passages of his paper.[2]

While I was considering these specimens from Mynydd Mawr, I received from Mr. P. F. Kendall, F.G.S., of Stockport, a pebble of eurite from the drift of the North of England. Both Prof. Sollas, who kindly examined it, and myself were satisfied that the broad dark patches in the yellow groundmass of this rock represented a blue amphibole, and hence probably a variety rich in soda. Mr. Kendall had been independently struck with the same idea, and had consequently compared his specimens with the rock of Mynydd Mawr. He has allowed me to have sections prepared of two pebbles, one collected in the Isle of Man, the other, curiously enough, from Moel-y-Tryfan, close to the western face of Mynydd Mawr. But, apart from the presence of the interesting slate-blue amphibole, the rock has no close resemblance to any now exposed at Mynydd Mawr. Mr. Harker[3] has referred, however, to pebbles of the Mynydd Mawr rock in the drift of the neighbourhood; and it is quite possible that both these soda-eurites, from different sources, may have been brought together during the formation of the glacial beds. Suffice it that Mr. Kendall's specimens, as he himself points out, have more in common with one another, though from such different localities, than they have with the rock of Mynydd Mawr.

Thus in the specimen from the drift on Moel-y-Tryfan the structure is that of the coarser types of eurite. We have a beautifully developed micro-pegmatitic, but not spherulitic, groundmass; and, intimately associated with this, ophitic crystals of blue-green amphibole. At times the amphibole has developed soon after the separation of idiomorphic felspar, and has thus produced a patch in the rock from which quartz is locally excluded. In other places micro-pegmatitic growths of quartz and orthoclase have been filled in, and in part surrounded, by ophitic amphibole. This micro-pegmatite occurs in straggling patches, as in much of the well-known enstatite-diorite of Penmaenmawr; if we may regard these as

[1] *Geol. Mag.* 1888, p. 455.
[2] *Min. Mag.* Vol. VIII. p. 107.
[3] *Geol. Mag.* 1888, p. 224.

ginal products of consolidation, as I am inclined to do, areas remained ween them in which less stable felspars were afterwards developed. ese have decomposed to a dusky brown tint, leaving the micro-pegmatitic ches, together with the amphibole, remarkably fresh and clear. It ıld appear, indeed, as if the micro-pegmatite, and also the porphyritic stals of quartz and orthoclase, represented a previous attempt at stallisation during quiet conditions of consolidation; the material was, vever, broken up and set in motion, and the subsequent devitrification the interstitial glass has given us the dusky areas. The characteristic phibole appears also in the latter, but in the form of minute rods and nules.

The porphyritic crystals of quartz contain brown glass-enclosures, often h bubbles, and bear very little resemblance to the quartz of old granitic ks. The amphibole occurs here and there in fair-sized crystals, but still h a tendency to ophitic inclusion of felspar at the edges, and with a conse- nt lack of idiomorphic outline. But such sections are much more easily ied than those of the same mineral at Mynydd Mawr, and the agree- nt of the optical characters of this amphibole with Sauer's riebeckite be satisfactorily demonstrated. The approximate coincidence of the ction of greatest elasticity with that of the principal axis of the crystal ıld remove the amphiboles of Mr. Kendall's specimens from the ordinary l-known types; the intensity of the pleochroism, and the fact that igo-blue rather than blue-violet axis-colours appear, show, moreover, nce that we are dealing with a mineral less familiar even than glau- hane.

I need say nothing of the pebble from the Isle of Man, beyond that it eats in a remarkable degree the characters of that from Moel-y-Tryfan. this respect the microscopic evidence only bears out Mr. Kendall's urate judgment in the field; and geologists will be glad to learn to ıt locality he may be able to trace these interesting erratics.

The nature of the riebeckite crystals in the specimens from the drift not permitted me to make very exact determinations of their extinctions; sponge-like structure of so many, owing to the multitude of ophitic losures, renders the observer cautious in judging of their orientation. t in those examples where I have felt more secure, I have read off a ger angle between c and a than is recorded for typical riebeckite. I e thus obtained 6°0′, 8°5′, 9°45′ and 8°0′. It is, however, reasonable suppose that variations towards normal amphibole will be found in this uliar group of forms, just as among soda-pyroxenes the extinctions part widely from the small angle of strictly defined ægirine and acmite.

It will be interesting to learn, as our knowledge of soda-amphiboles increases, whether riebeckite is typical of rocks of igneous origin, while glaucophane arises in regions of pressure-metamorphism ; or whether the peculiar relation of the axes of elasticity to those of form depends, as at present appears, purely on chemical constitution, viz. on the presence or absence of iron oxide.

a rapid method for the accurate recognition of sulphides, arsenides, antimonides, and double compounds of these bodies with metals.

By Charles A. Burghardt, Ph.D., &c.

[Read January 27th, 1891.]

HE process to be described has been applied to the minerals mentioned below, but I have no doubt that all similarly constituted minerals also be easily recognised by the method.

am quite sure that all mineralogists have experienced much annoyance difficulty in obtaining really satisfactory results with the ordinary blow- reactions in regard to some of the compounds of arsenic, antimony, and hur with metals, particularly in the separation of the metal or metals the above-mentioned elements. In order to obtain the metal the requires a most careful and tedious roasting on charcoal in the *dising flame* of the blow-pipe, in order to volatilise away the sulphur, nic, or antimony. When this roasting is complete the residue (oxide) nixed with either sodium carbonate, or that salt and cyanide of potas-, and fused for a considerable time on charcoal in the reducing flame order to obtain a bead of the metal. Sometimes borax is used to inate a metal from a mixed oxide residue, dissolving one oxide leaving the other. If the oxides left after the oxidising process ve-mentioned are not soluble in borax, then the bead which is ined in the subsequent reducing process is an alloy, and prac-lly useless as a means of recognition of the metals entering into its position. Having often been disappointed with the results obtained the above-mentioned blow-pipe processes, I determined to find, if pos-e, a more rapid and certain method of analysis of minerals.

The apparatus required is that which all mineralogists have been in the it of using for a long period, viz.

st. Small porcelain crucibles.

nd. Test-tubes.

rd. A small platinum basin and a platinum crucible.

4th. A platinum spoon made rather deep, something like a platinum crucible with a handle.

5th. Hard-glass tubing, closed at one end and about 4in. long; a cork is placed in the open end, with a hole bored through it, and a hard-glass tube of small bore passed just through the cork. The straight piece outside the cork is bent either *twice* at right angles (if required to pass vapours into water or solution), or *once* at right angles, and drawn out to a fine nozzle if required to test for arseniuretted or antimoniuretted hydrogen.

6th. A Bunsen burner of the ordinary type, or a spirit-lamp.

7th. Funnels, beakers, porcelain evaporating basins, stir-rods, &c. &c. and small pieces of clean sheet-iron and sheet-copper.

	Reagents.
Ammonium nitrate	(solid)
Sodium nitrate	,,
Potassium bi-sulphate	,,
Metallic zinc	,,
Hydrochloric acid	(solution)
Potassium ferrocyanide	,,
Potassium ferricyanide	,,
Ammonia-liquor	,,
Caustic soda	,,
Silver nitrate	,,
Stannous chloride	,,
Bi-chromate of potassium	,,

All the above reagents can be carried about in the *dry solid* condition for travelling, except the hydrochloric acid and the ammonia. With regard to the latter it can be carried in the form of solid ammonium carbonate or ammonium sulphate; and the ammonia liberated from the respective salts in the usual manner, and passed either into the solution to be tested or else into water. I cannot at present give as easy a way of producing hydrochloric acid when it is wanted from dry materials, but think that it could be prepared in sufficient quantity by heating together in a glass tube (with delivery tube attached as described above) a mixture of potassium or sodium bi-sulphate and sodium chloride. Hydrochloric acid gas would then be liberated. Nitric acid is not required in this method at all.

Having thus briefly touched upon the present method of the treatment by the blowpipe of the minerals containing volatile elements, I will at once proceed to describe the method proposed by myself to attain the

same object. The oxidising reagent I use is pure *crystallised ammonium nitrate*. This salt, on being heated to about 250° C., decomposes, intumesces, and the products of its decomposition are nitrous oxide (N_2O) and water. *Thus the products are both gases, and nothing remains behind, which is certainly a very great consideration.* The *nitrous oxide*, at the high temperature used, rapidly gives up its *oxygen* to any element having an affinity for that gas, and *oxidises* it, so that finally the principal decomposition products of the original ammonium nitrate which are evolved as gases are nitrogen and vapour of water. The *modus operandi* is exceedingly simple. The mineral to be tested is crushed up and powdered into an exceedingly fine powder, a platinum or porcelain crucible is taken and filled to about one-fourth of its bulk with coarsely crushed ammonium nitrate crystals, then upon this about 0·5 gram of the finely powdered mineral is placed, and the crucible and contents held with a pair of tongs over the Bunsen lamp, just in the flame. A violent reaction is at once set up, and care must be taken to withdraw the crucible from time to time from the lamp in order to avoid loss by boiling over the sides. Sometimes it is necessary to add some more ammonium nitrate crystals to the partially cooled "melt" in the crucible and heat again in order to complete the reaction. *An excess of ammonium nitrate cannot possibly do any harm, and it ensures success.*

The crucible having been allowed to cool, the contents are extracted with water and the solution separated from the insoluble matter. During the fusion of the mineral in the crucible, characteristic colours of various metallic salts are most distinctly observed, occasionally, therefore, the operator must watch this fusion closely. The fusion and lixiviation of the melt only occupy a minute or two when one has attained some experience, but the whole analysis need not exceed fifteen minutes even in complicated compounds. When melting the mineral in a glass tube with the ammonium nitrate and passing the products of combustion into water, care must be taken to carefully dry the ammonium nitrate in a water oven previous to use, as it rapidly absorbs moisture from the air, and the water thus evolved in the fusion tube would cause the hot glass to crack. The thoroughly dried ammonium nitrate is conveniently kept in a *well stoppered* bottle.

Sulphides of Arsenic.

Orpiment (As_2S_3).

Realgar (AsS).

Fused in glass fusion tube with tube bent twice at right angles, the open end of the delivery tube dipping into water. Sulphuric acid was found in

the water in distinct quantity by the usual barium chloride test; therefore the mineral was a *sulphide*. In the fusion tube was a slightly coloured solid residue which could be eventually completely dissolved in boiling water; it gave the reaction for *arsenic acid* (with nitrate of silver) and all the other reactions for arsenic; mirror on being treated with metallic zinc and acid potassium sulphate, and the arseniuretted hydrogen, decomposed into metallic arsenic by heating the hard-glass delivery tube to redness. *The mineral was therefore arsenic sulphide.*

Antimony Sulphide.

Stibnite (Sb_2S_3).

Fused in the same kind of apparatus as that used for the sulphides of arsenic, yielded sulphuric acid in the water and a mixture of Sb_2O_3 and Sb_2O_5. A little sulphuric acid was also detected in the water which had been used to boil the residue in the fusion tube. On adding a solution of potassium bisulphate to the residue in the fusion tube, and a piece of pure metallic zinc, antimoniuretted hydrogen was at once evolved, and a mirror of metallic antimony obtained on heating the delivery tube to redness. Other tests applied proved this mirror to be really antimony. The mineral did not give reactions for any other element likely to be present, hence it was *sulphide of antimony*.

If it is suspected that both arsenic and antimony are present in a mineral in large amount, they can be easily separated from each other by substituting *sodium nitrate* for ammonium nitrate, when a compound of antimony and sodium, insoluble in cold water, is obtained (antimonate of sodium), whilst the arsenic forms arsenite and arsenate of sodium, both of which are soluble in cold water after standing some time.

Löllingite.

$Fe\,As_2$.

Fused with ammonium nitrate in a platinum crucible or porcelain crucible. Melt red-coloured. Dissolved in hot water gave the reactions for arsenious and arsenic acid with silver nitrate and the usual arsenic reactions. The insoluble residue gave the reactions for iron. The mineral was therefore an *arsenide of iron*.

Proustite.

Ag_3AsS_3.

Fused in the same manner as the last-mentioned mineral, yielded a *black* residue containing arsenic oxide (this residue will be the subject of special examination, as it is peculiar). The melt was treated to separate

ue black residue. A solution of silver sulphate was obtained, which gave ue characteristic reactions for silver and sulphuric acid. The black sidue was treated with the acid-potassium-sulphate solution and metallic mc, and arsenic was detected in the usual manner. The solution in ater also gave the characteristic reaction for arsenic acid with silver trate. All the silver of the proustite was converted into sulphate, account of the high percentage of sulphur in this mineral. The mineral as therefore a *sulph-arsenite of silver*.

Pyrargyrite.

$Ag_3\ Sb\ S_3$.

reated in the same way as the preceding mineral, sulphate of silver was tained in solution in water, and insoluble antimonious and antimonic ide (Sb_2O_3 and Sb_2O_5) remained as a residue. The antimony reactions re obtained, and only silver and sulphuric acid detected, consequently e mineral was a *silver sulph-antimonite*.

Argentite.

Ag_2S.

On treating this mineral in the same manner as pyrargyrite, sulphate of ver was produced in small amount, owing to the small percentage of phur present in argentite. On adding a small quantity of "flowers of phur" to the powdered mineral, and then fusing the mixture with the monium nitrate, a larger quantity of silver sulphate was obtained. The ution gave the reactions for silver and sulphuric acid only, consequently e mineral was a *sulphide of silver*.

Iron-Pyrites.

Marcasite. Pyrites. FeS_2.

sed as above gave a reddish brown residue of ferric oxide (Fe_2O_3) d a brown solution in water, which gave the characteristic reaction for *ric*-salts with potassium ferrocyanide solution, and also the reaction for phuric acid. The mineral was therefore *sulphide of iron*.

Galena.

PbS.

ve a *white* residue (insoluble in water) of *lead sulphate*, and nothing in ution. The residue was dissolved in hot hydrochloric acid, when a tion of the solution gave a white precipitate (of barium sulphate) on addition of a solution of barium nitrate, and another portion of the drochloric acid solution, on being neutralised with sodium carbonate

and boiled with a solution of potassium bichromate, gave the charac teristic yellow lead chromate reaction. The white lead sulpha residue mentioned above, on being treated *directly* with the solution potassium bichromate, also gave the lead chromate reaction. The miner was therefore a *sulphide of lead*.

Copper-glance (*Redruthite*).

Cu_2S.

Gave a *blue* melt *whilst hot*, which became brown on cooling. The me dissolved completely in water into a blue solution, which gave the usu reactions for copper and sulphuric acid. The mineral was therefore *sulphide of copper*.

Bismuth-glance.

Bi_2S_3.

The melt was brown when cold. A solution of *sulphate of bismu* was obtained, which gave the reactions for bismuth and sulphuric aci An excellent and delicate reaction for bismuth is that which was shown me by Professor Bunsen at Heidelberg 21 years ago, which I have nev yet seen described in any work on qualitative analysis. In applying it the solution of the melt first add a slight excess of caustic soda solu tion to it, when a *white* precipitate of hydrated bismuthic oxi (Bi_2O_3 H_2O) is obtained. In another vessel add an excess of caustic so solution to a solution of stannous chloride, when a white precipitate hydrated stannous oxide (SnO H_2O) falls out, but immediately re-di solves in the excess of caustic soda. The bismuth precipitate obtain as above is washed into a white basin and a portion of the caust stannous solution poured upon it and well stirred with it, when very so a dense *black* precipitate is seen in the white basin, this precipitate bei an oxide of bismuth Bi_2O_2, formed by the reduction of the Bi_2O_3 throu the SnO.

Millerite.

Ni S (with Co and Fe).

Gave a *green* solution of sulphate of nickel, which gave the characteris reactions for nickel and sulphuric acid, and also those for cobalt and iro There was an insoluble brown residue of ferric oxide from the melt.

The mineral, therefore, was a *sulphide of nickel.*

Copper Pyrites.

$CuFeS_2$.

Gave the same reactions as those obtained in the case of chalcocite, *wi the addition* of a copious reddish brown insoluble residue from the melt

rric oxide. The solution of the melt in water was *blue.* The melt in ie crucible was reddish-brown.

The mineral was therefore a *sulphide of copper and iron.*

Bournonite.

$Cu\ Pb\ SbS_3$

Melt after fusion *yellowish-green.* Treated with water gave a solution of *pper sulphate,* in which both copper and sulphuric acid were detected as chalcocite, &c. The insoluble residue (after dissolving out all the copper lphate) was found to be sulphate of lead and antimonious and antimonic ides. A portion of this insoluble residue was treated with acid sulphate potassium (as in stibnite), when all the antimony was eliminated as *timoniuretted hydrogen,* and the residue of lead sulphate treated as the lphate of lead obtained from galena, and the presence of lead demonrated.

The mineral therefore was a *copper-lead sulph-antimonite.*

Tetrahedrite, or Fahl-ore.

$Cu_8\ Sb_2\ S_7$.

The melt was *green whilst fusing,* but *brown* when cold. Treated with ater gave a *blue* solution of copper sulphate, ferric sulphate, and traces of nc sulphate and arsenious acid. The usual tests were applied to this lution, and copper, iron, and sulphuric acid detected.

The residue insoluble in water was found to be antimonic oxide (Sb_2O_5) l ferric oxide. On boiling the residue with *caustic potash* the Sb_2O_5 was ssolved and the ferric oxide remained. On adding hydrochloric acid excess to the antimonate of potassium and a piece of metallic zinc antiioniuretted hydrogen was detected in the way described above.

The mineral therefore was a *copper-iron,—&c. sulph-antimonite.*

Smaltite.

$(Co, Fe, Ni)\ As_2$.

The melt was *pink* whilst fusing. Treated with water and boiled, an soluble residue of cobalt, iron and nickel oxides remained, whilst *rsenious acid* passed into solution, and the arsenic was detected in the sual manner. The oxides of the metals thus obtained were dislved in hydrochloric acid and tested chemically for cobalt and nickel, so iron, and these metals were detected.

Where arsenic and antimony combine with metals forming antimonides id arsenides, *and no sulphur is present,* oxides of the metals are obtained gether with oxides of antimony and arsenic. By adding sulphur to

these compounds, *the metals are converted into sulphates and becon soluble.*

I have still to discover a good method for the separation and detectic of cobalt and nickel, suitable for mineralogical analysis.

In conclusion I must acknowledge the great assistance I have receive from my assistant, Mr. Gilbert Rigg, in this investigation.

NOTE.—Since writing the above I have made some further experiment and have succeeded in separating cobalt from nickel in the most comple manner. If the mineral is an arsenide or antimonide of cobalt and nick it is fused as described in the treatment of smaltite, and when all th metals are converted into oxides a lump of ammonium nitrate is added the melted mass from time to time, and the whole is kept gently simmerin for three or four minutes. The melted mass assumes a pink colour due the formation of nitrate of cobalt. After cooling the melt is boiled o with water; NiO remains behind absolutely free from CoO. The cobs nitrate solution is evaporated to dryness in a porcelain basin and ignite at about 250°C, when all the ammonium nitrate present is volatilised ar pure pink cobalt nitrate remains in the basin. If the mineral is a sulphi of nickel and cobalt fuse it with 10 per cent. of its weight of powder carbon (previously added to the powdered mineral), and about four times i weight, or more, of caustic soda in a silver crucible. Sodium sulphide produced, and dissolved out by water from the cooled melt, and the oxid of cobalt and nickel remain behind; they are then treated with ammoniu nitrate as described above. C. A. B.

A System for constructing Crystal Forms by the Plaiting of their Zones.

By J. Gorham, M.R.C.S.

(Abstract.)

[Read January 27th, 1891.]

IN this paper the author described his method of constructing crystal models of paper or cardboard by means of plaiting. In the ordinary crystal "nets" (such as, according to Mr. Gorham, were constructed by himself and shown at the Royal Society as early as 1847) the faces of the model are drawn in juxtaposition on cardboard and cut out, some of the edges being only partially cut through; the net is then folded up so as to form a solid figure, and the faces are united at their edges by gum.

In the models described and exhibited by Mr. Gorham, the faces are so drawn as to be disposed along strips; these strips are united to each other at one end, and can then be folded together by a process resembling plaiting, in which the strips pass alternately under and over each other. In this way models are made precisely like those constructed from the ordinary nets, but requiring no cement; models which can, moreover, be taken to pieces (unplaited) and laid flat, or re-constructed whenever desired.

Each strip contains the faces lying in one zone, and the number of strips employed by Mr. Gorham is either three or four; the cube, for instance, is formed by the plaiting together of three, and the dodecahedron by the plaiting together of four strips.

Their order of succession is the same for each model whatever its form. Thus the strips of square faces from which the cube is constructed are three in number, and if they be denoted by the numerals 1, 2, 3 respectively, the process of plaiting always pursues the following order:—

1 passes over 2
then 3 „ 1
then 2 „ 3 and so on.

Any model consisting of three strips is plaited in the same order.

A peculiar (and a new) feature of the models exhibited at the meetin is that their faces are traversed by lines; one strip is marked by a sing line, the second by a double, and the third by a triple line. These line fulfil a twofold purpose: (1) by their direction they show the numbe and disposition of the zones in each crystal (and indicate the order i which the strips are to be plaited); and (2) the alternate appearance an disappearance of the lines, that is to say their appearance on alterna faces of the model, is strongly suggestive of their being intertwined lik a plait, as is of course the fact. It is to this alone that the model indebted for its solid form and its power of retaining the same.

REVIEWS.

An Introduction to the Study of Petrology: The Igneous Rocks. By F. H. Hatch, Ph.D., F.G.S., of the Geological Survey of the United Kingdom, with forty-three illustrations. London: Swan, Sonnenschein and Co., 1891.

English students and teachers have long felt the want of a convenient text-book dealing with the characters of the common rock-forming minerals and the chief types of rocks; and this want has now been admirably supplied by the publication of Dr. Hatch's little manual. In its general plan and in some of its details the book recalls many of the excellent features of the *Einleitung in die Petrographie*, the publication of which was one of the last among the great services rendered to geological science by the late Dr. A. von Lasaulx. In describing the means by which the rock-forming minerals may be distinguished from one another, Dr. Hatch wisely considers the requirements of the beginner, and dwells briefly on those peculiarities which can be recognised without special optical appliances; the diagnosis which he gives with each species, being at the same time terse and accurate, is admirably adapted to the wants of the student. For the special optical characters, which are less easy of determination in ordinary thin sections, the reader is referred to more elaborate treatises on the subject, like that of Rosenbusch.

In the vexed question of rock nomenclature the author, while following the most recent German authorities, does wisely in referring also to the names employed by French and other authors. We think that something more might have been done with respect to those terms which are employed by modern German writers with significations different from those which were originally given them by their authors.

Dr. Hatch very properly points out that "Syenite" and "Gabbro" are now employed in a sense totally different to that in which they were understood by the older geological writers: he might have done the same with Vogelsang's names "Granophyre," "Felsophyre," and "Vitrophyre," the old French names "Minette" and "Kersantite," and several of Gümbel's names, which have been re-defined by Rosenbusch. The policy of taking old names and changing their definition is at best a very

doubtful one; but it unquestionably entails upon the writers of text-books the duty of making clear the exact nature of the change and the date at which it has been made. If this be not done, the student who consults any geological paper written before the date of the proposed change is liable to be betrayed into serious errors. The book is admirably printed with clear and useful drawings, taken for the most part from Fouqué and Lévy's admirable work, and it may be recommended to all beginners in this interesting study. J. W. J.

Asbestos: Its Properties, Occurrence and Uses. By R. H. Jones. Crosby, Lockwood and Sons. London, 1890.

This volume is an extension of a pamphlet issued by the author some three years ago on the same subject, which is here expanded into a treatise on the nature, sources, production and uses of asbestos, with supplementary chapters on its substitutes, and on fibre-spinning.

The term asbestos is used to include all substances which are commercially understood by that name; and under varieties of asbestos the author gives brief descriptions of the fibrous amphiboles, pyroxenes and serpentines. We are glad to note that he is here careful to distinguish between the Canadian "asbestos," or Chrysotile, and the Italian asbesto proper, a distinction which was by no means made clear in the above mentioned pamphlet. As regards the production, mode of occurrence and commercial uses of these minerals, the author deserves considerable praise for the manner in which he has treated the subject. The book contains a large amount of useful and interesting information, not easily accessible elsewhere, and is adorned by some excellent plates.

It is written, no doubt, to satisfy the wants of the general reader, who does not look for much accurate scientific information, and is obviously intended to call special attention to the Canadian "asbestos," perhaps somewhat to the disparagement of its Italian rival.

In a scientific journal we may be pardoned if we direct attention to the defects of what professes to be the scientific part of the book.

In this section the unscientific reader must be on his guard lest he accept the following as a history of the production of chrysotile:—"When first formed the serpentine is probably in a soft or pasty state, and contracts as it hardens (as if from drying), and in thus contracting breaks into thin, irregular, usually nearly parallel plates, incurving; and in the intervals between these plates the serpentine crystallises in the fibrous form we call chrysotile;" neither are "precious stones" generally sup

posed to be "volatilised in the clefts of the igneous rocks, and there turned into brilliant crystallisations."

Why, again, should the elevation of Griqualand West above the sea level lead to the expectation that asbestos will be found there?

Cat's-eye is described as a chalcedonic quartz; the tensile strength of crocidolite is attributed to the large amount of iron in its composition; and "pikrite" is described as a "bitter fibrous variety of serpentine."

The book, in spite of such blemishes, contains a really interesting account of the Canadian mines.

Abstracts.

Formation of Minerals in Slags and Lavas compared. In the *Archiv for Mathematik og Naturvidenskab, Christiania* (1889) J. H. L. Vogt is giving an exhaustive *résumé* of what is known on this subject, with a large amount of new material, the object being to inquire (1) what chemical and physical conditions govern the formation of artificial minerals from a molten silicate-magma without water, steam, or *agents minéralisateurs* such as HF, and (2) how far these conditions are realised in the 'younger' volcanic rocks.

The magmas dealt with are such as contain (besides SiO_2) Al_2O_3, Fe_2O_3, FeO, MgO, CaO, MnO, Na_2O. and K_2O; not TiO_2, SnO_2, ZrO_2, WO_3, P_2O_5, B_2O_3, SO_3, CO_2, &c., nor the rarer bases PbO, ZnO, Li_2O, &c. The minerals known to be formed artificially from dry fusion are the olivine-group; the rhombic pyroxenes; the monoclinic and triclinic pyroxenes (augite, wollastonite, rhodonite, babingtonite); the lime and lime-soda felspars, albite (doubtful), but not the potash and potash-soda felspars; melilite and gehlenite; nepheline; leucite; magnesia-mica; garnet; and tridymite. There are also certain minerals not yet known in nature, such as the hexagonal and tetragonal lime-silicates, and others isomorphous with natural minerals, *e.g.* the lead-anorthite of Fouqué and Michel Lévy, in which PbO replaces CaO: finally the non-siliceous minerals,—spinels, magnetite, and hæmatite. Cordierite and idocrase are doubtful, as are meionite and other members of the scapolite series. Minerals not yet formed from dry fusion are quartz, orthoclase, microcline, anorthoclase, albite (?), the amphibole group, potash-mica, tourmaline, the pure alumina-silicates (andalusite, disthene, and sillimanite), topaz, staurolite, &c.: also, according to the author, the scapolite series, idocrase, cordierite, and the epidote group. Several of these minerals, however, do not occur in the younger lavas.

Under the olivine group we have forsterite, fayalite, and common olivine (with Mg and Fe), tephroite and the Mn-bearing olivines, monticellite and the lime-bearing olivines. These, except the last, are readily formed from slags, appearing as the earliest minerals to crystallise out. Monticellite is found in nature only in crystalline limestones, and the olivine of lavas

contains little or no lime, though this base enters more readily into the composition of artificial olivines. The author examines the effect of the percentage of lime on the angles of the crystals.

With respect to the augites, the question arises whether the non-aluminous augites (diopside and hedenbergite series) have the exact formula $CaRSi_2O_6$, where R = Mg, Fe, Mn, or whether the ratio Ca : R may vary. It appears that the composition of artificial augites varies from $3CaSiO_3$, $MgSiO_3$ to $CaSiO_3$, $3MgSiO_3$. Excess of lime above the former limit appears as the hexagonal $CaSiO_3$; excess of magnesia above the latter limit as a rhombic pyroxene. With regard to the aluminous augites, it is inquired whether they can always be represented by the formula $RSiO_3 + nAl_2O_3$ or $RRSi_2O_6 + nRAl_2SiO_6$, or whether the alumina ever enters in some other combination. Microscopical examination shows that augite slags which are more acid than a bisilicate, *i.e.* contain more silica than the formula $RSiO_3 + n(AlFe)_2Si_3O_9$, always have more or less glassy residue. Those slags, however, which have a composition very near that of a bisilicate (two especially are cited with oxygen-ratios 2·00 and 1·97 respectively), crystallise completely as augite with no glass. The bulk-analysis of such a slag is therefore also that of the augite. Since the atomic-ratio Si : R in these is found to be not 1, but 1·23 and 1·25, the formula cannot be $RSiO_3 + nAl_2O_3$, and calculation shows that it is $RSiO_3 + nAl_2Si_3O_9$. It further appears that augite must form from magmas having approximately the composition $RSiO_3 + nAl_2Si_3O_9$, while we must expect quite different minerals (olivine, melilite and gehlenite, magnesia-mica, plagioclase) from magmas of composition $RSiO_3 + nAl_2O_3$. In natural augites the Al_2O_3 and Fe_2O_3 seem almost always to enter according to the formula $RSiO_3 + n(AlFe)_2O_3$ or $RRSi_2O_6 + nR(AlFe)_2SiO_6$; the combination $(AlFe)_2Si_3O_9$ occurs only exceptionally, but cases of it are quoted, besides the analogous occurrence of $Fe_2Si_3O_9$ in acmite and babingtonite.

The lime-silicate formed from dry fusion of magmas mainly consisting of $CaSiO_3$ is only very exceptionally wollastonite, in general a dimorphous substance in short hexagonal prisms, supposed to be truly hexagonal, but with optical anomalies. It may take up a small amount of $MgSiO_3$, but if the ratio Mg : Ca in the magma exceeds 1 : 4 an augite is formed instead. Alumina does not appear to enter into the constitution of this hexagonal mineral.

Enstatite and a dimorphous form of $MgSiO_3$ may be formed side by side from artificial magmas. Two slags having 5·5 and 3·5 times as much Mg as Ca, gave rise to the formation of both enstatite and augite, the latter often grown round a kernel of the former. The enstatite contains

very little Ca, and the lime being thus concentrated in the 'mother-liquor,' augite is formed instead, after a certain point. The same slags also exhibit the new $MgSiO_3$, which belongs to one of the oblique systems. Fouqué and Michel-Lévy regarded it as monoclinic, and called it a MgO-pyroxene; but its cleavage and twin-lamellation differentiate it from the augites, and it may be triclinic. In like manner hypersthene ($FeSiO_3$) is found to have in artificial slags a dimorphous companion, mono- or triclinic with twin-lamellation and a basal cleavage distinguishing it from the augites.

Rhodonite forms very readily in Mn-bearing silicate-slags. The artificial crystals have almost always the combinations and habit of type 5 of Flink's series from Pajsberg and Längban, the shape being markedly tabular.

The memoir is not yet completed. A. H.

The Minerals of the Garnet Group (W. C. Brögger and H. Bäckström). (*Zeitschr. f. Krystallographie*, XVIII. pp. 209-276).

In this important paper the authors include under the garnet group all the orthosilicates belonging to the cubic system; the group is separated into two divisions, the first including those members which are of tetrahedral habit and cleavage, the second those whose habit and cleavage are dodecahedral. The first division comprises eulytine, zunyite, danalite, and helvine; the second division comprises garnet, sodalite, nosean, hauyne, lapis lazuli. Of these the last four are regarded by the authors as alkali-garnets, whose constitution is explained as follows.

The formula of a lime-alumina-garnet being $Ca_3\,Al_2\,(SiO_4)_3$ that of sodalite is regarded as $Na_4\,[AlCl]\,Al_2\,(SiO_4)_3$, in which two atoms of Ca have been replaced by four of Na, and one of Ca by the divalent group Al Cl.

The composition of nosean and hauyne is expressed by the formula $Na_4\,[Al\,(NaSO_4)]\,Al_2\,(SiO_4)_3$ which is derived from that of garnet by replacing Ca_2 by Na_4, and Ca by the divalent group $Na\,SO_4\,Al$.

It need scarcely be pointed out that the above formulæ are totally different from those generally received. For example, Clarke and Groth express the constitution of sodalite as $Na_5\,Al_4\,(SiO_4)_4\,Cl$.

A formula practically identical with that here adopted has only previously been suggested by Safarik.

The larger part of the paper is devoted to an examination of the nature and composition of lapis-lazuli, which has hitherto been generally regarded as a variety of hauyne.

The authors find by an elaborate study of the best available specimens of lapis-lazuli that the substance is a contact mineral produced at the margin of dolomitic limestone, and is, in fact, a lime-silicate hornfels in which the lime-alumina-garnet generally characteristic of such rocks is replaced by a blue constituent having the composition of an alkali-garnet.

The typical constitution of this blue colouring matter is expressed by the formula—

$$Na_4\ [Al\ (S_3Na)]\ Al_2\ (SiO_4)_3$$

Denoting this substance U S_3, and using the symbol U S_2 to represent a substance having the composition $Na_4\ [Al\ (S_2Na)]\ Al_2\ (SiO_4)_3$, in which the radicle $NaSO_4$ of hauyne is replaced by the radicle S_2Na; and similarly using U S_1 to denote a substance into which the radicle SNa enters in place of the same; the authors find that the colouring matter of artificial ultramarine is also the substance U S_3.

A criticism of the various analyses of ultramarine then shows that the discrepancies hitherto remarked in the results of different observers may be explained by assuming that this substance is an isomorphous mixture in varying proportions of the following five homœomorphous compounds:—

$$US_1,\ US_2,\ US_3,\ Na_2Al_2Si_3O_{12},\ Na_2Al_2Si_4O_{12}$$

It is impossible in a short abstract to do justice to a paper which is the result of elaborate research and contains so much that is new; for the detailed account of the numerous observations and experiments upon which the authors base their views reference must be made to the original memoir. H. A. M.

Pinakiolite and Trimerite, two new minerals from the Manganese mines of Sweden, are described by G. Flink. (*Zeitschr. für Kyrstallographie*, 1890, XVIII. 361.)

Pinakiolite, which is found in small plates at Längbanshyttan in Wärmland, and is named from *πινακιον, small table*, and *λιθος, stone*, is associated with dolomite and hausmannite, and occurs in bands of crystalline laminæ in the dolomite. With it are found tephroite, small scales of manganophyllite, berzeliite, &c.

The characters are as follows:—

Sp. gr. = 3·881; Hardness = 6; very brittle; melts with great difficulty to a black non-magnetic mass; with bisulphate of potash and fluor spar the mineral colours the flame intense green. Reactions for manganese strongly marked. Dissolves in hydrochloric acid with evolution of chlorine, while flocculent silica is formed in the solution.

After deducting water and silica, regarded as impurities, from the quantitative analysis, and calculating to 100, a result is obtained corresponding to the formula (MgO). B_2O_3. MnO. Mn_2O_3.

The analysis was as follows:—

	Found.
B_2O_3	16·05
MgO	29·30
Mn_3O_4	50·63
Fe_3O_4	2·12
CaO	1·12
PbO	0·78
	100·00

Crystalline system, Rhombic, $a : b : c = 0{\cdot}83385 : 1 : 0{\cdot}58807$.

Cleavage fairly perfect, parallel to the plane of the tables, which is here taken as brachypinakoid; imperfect in the direction of an undetermined macrodome; colour pure black; lustre strongly metallic. Colour of the powder brownish grey, which on heating becomes black. Very thin slices are transparent, strongly pleochroic. The acute negative bisectrix is perpendicular to the plate, and the axial angle is probably about 60°, the plane of the optic axes being the basal plane. The above orientation is adopted to show the analogy with Ludwigite.

Trimerite from Harstigen in Warmland is named from τριμερης, *tripartite*, and has the following characters:—

Sp. gr. = 3·474. Hardness, 6-7. Cleavage basal, distinct. Fracture conchoidal.

Before the blow-pipe thin splinters melt in the hottest part of the flame, and form a dark mass. Silica, iron and manganese are easily recognised by the blow-pipe reactions. The powdered mineral dissolves in hot hydrochloric acid with separation of flocculent silica. Analysis leads to the formula—

$$Mn_2\,SiO_4 + Be_2\,SiO_4$$
$$\text{or } (Mn\,Be)\,SiO_4.$$

as shown by the following result:—

	Found.
SiO_2	39·77
BeO	17·08
MnO	26·86
FeO	3·87
CaO	12·44
MgO	0·61
	100·63

The crystals are apparently short hexagonal prisms terminated by the basal plane and two pyramids, and goniometrical measurements give angles corresponding to the hexagonal system. It is shown, however, by Prof. W. C. Brögger, who investigated the optical properties of the crystals, that they are really asymmetric, being made up of three asymmetric individuals having a prism angle of 120°; lustre vitreous; colour yellowish-red; transparent. C. J. W.

In a suggestive paper immediately succeeding that of Flink, Prof. W. C. Brögger (p. 377) discusses the morphotropic relation of Pinakiolite and Trimerite to allied minerals, and shows that although apparently so widely separated, they may be placed in a morphotropic series, including Ludwigite and Willemite, to which they are obviously related, and also several other minerals, which are not generally brought together.

This series consists of the silicates R_2SiO_4, and the aluminates, ferrates, manganates and borates represented by the formula RX_2O_4.

In the silicates R = Ca, Fe, Mg, Mn, Zn, Be, &c., or (H_2Cu).

In the aluminates, &c., R = Be, H_2, (Mg_2O).

X = Al, B, Fe, Mn.

The crystals of the whole series, though belonging to different systems, are always characterised by one zone, with angles of about 60°, and exhibit a hexagonal or pseudo-hexagonal habit.

To this series Brögger refers the following minerals:—

Rhombic: Chrysoberyl, Diaspore, Manganite, Göthite.
Ludwigite, Pinakiolite.
Olivine group.

Pseudohexagonal: Trimerite.

Hexagonal: Phenakite, Willemite, Dioptase.

All these minerals resemble each other in habit, symmetry and mode of twinning. H. A. M.

Hamlinite, a new rhombohedral mineral from the Herderite locality at Stoneham, Maine, is described by W. E. Hidden and S. L. Penfield. (*American Journal of Science*, Vol. XXXIX., 1890, p. 511.)

The mineral occurs as minute rhombohedral crystals attached to herderite and margarodite, and is associated with the rare beryllium silicate, bertrandite. Only an extremely small portion of the mineral has been obtained, and it is hoped that those who may have specimens of herderite will examine them, so that more material for analysis may be found.

The crystalline system is hexagonal (rhombohedral). The crystals vary from one to two millimetres in diameter, and are quite flat from the predominance of the basal pinakoid. They exhibit also the rhombohedra, R, $-2R$; the length of the vertical axis $c = 1{\cdot}135$ was calculated from the rhombohedron R = 108°2′.

Cleavage parallel to the base; lustre on basal plane pearly, on the rhombohedral faces greasy; transparent and colourless to faint yellow; double refraction positive, not strong; hardness 4·5; sp. gr. 3·228.

Fuses at about 4 to a white porcelain-like mass, colouring the flame pale green (P_2O_5); in the closed tube gives abundant water and etches glass (F). "We have therefore undoubtedly a new species, a phosphate (probably of beryllium and aluminium) containing fluorine, and one which promises to be of unusual interest." C. J. W.

Lussatite, a new crystallised mineral variety of Silica, is described by M. Er. Mallard (*Bull. Soc. Fr. Min.*, XIII. pp. 63-66).

The new mineral occurs on quartz crystals and on large chalcedonic concretions at Lussat, near Pont du Château, Puy de Dôme; also at Tresztyan in Hungary, and in some localities in Cornwall. It consists of fibrous or fibro-lamellar matter, the fibres lying at right angles to the surfaces of the quartz crystals. These fibres on analysis are found to be almost pure silica, a residue of 0·011 of a sulphate having been noted after the mineral had been treated with hydrofluoric and sulphuric acids. The fibres although themselves practically pure crystallised silica, are mixed with more or less amorphous silica (opal). The substance parts with eight per cent. of water on calcination. The fibres of Lussatite show distinct double refraction, but it is less strong than that of quartz. The extinction is exactly or almost exactly parallel to the length of the fibres, and the optical sign of the axis of elongation is positive. This serves to distinguish it from chalcedony, of which the optical sign is always negative. The double refraction of chalcedony is also stronger than that of Lussatite.

F. R.

Minerals from Maryland (Johns Hopkins Univ. Circ. No. 75).—G. H. Williams adds a number of minerals to the list published two years ago for the Baltimore district. The highly micaceous gneiss of that region contains, in addition to garnet, kyanite and fibrolite, large black crystals of staurolite, frequently twinned. The crystalline limestone contains, among other minerals, orthoclase (necronite or 'fetid felspar') a green muscovite, not chromiferous, and pink scapolite in imperfect crystals up to 4 cm. in length. The eruptive granite contains allanite (orthite) surrounded by a parallel growth of epidote.

A. C. Gill describes chrome-tourmaline and chrome-muscovite (fuchsite), associated with chromite in the serpentine masses of Montgomery County. The former mineral occurs in dark green needles up to 2 cm. in length. It shows strong dichroism, the ordinary ray being chrome-green, the extraordinary greenish straw-colour. Specific gravity 3·089 to 3·062. The analysis (I.) is by T. M. Chatard. Compared with Cossa and Arzruni's analysis (II.) of the Ural chrome-tourmaline, it shows less chrome-oxide and more magnesia. The chrome-bearing mica (fuchsite) is of a beautiful green colour. Its pleochroism is α = delicate robin's-egg blue, β = yellowish-green, γ = rich bluish chrome-green; and the axial angle is 71°24′ for Li, and 68°16′ for Na. Side by side with T. M. Chatard's analysis (III.) of this mineral is given the analysis (IV.) by Damour of fuchsite from the Urals. It will be seen that in both the minerals the American specimens contain less Cr than those from the Urals.

		I.	II.	III.	IV.
SiO_2	...	36·56	36·79	42·21	46·17
TiO_2	...	0·09	—	—	—
P_2O_5	...	0·04	—	—	—
Fl	...	0·06	0·65	—	—
B_2O_3	...	8·90	9·51	—	—
Al_2O_3	...	32·58	30·56	34·55	29·71
Cr_2O_3	...	4·32	10·86	2·03	3·51
Fe_2O_3	...	0·79	(FeO 2·91)	1·03	2·09
NiO	...	0·05	—	—	—
MnO	...	strong trace	—	—	—
MgO	...	9·47	4·47	3·13	2·28
CaO	...	0·75	0·72	0·47	—
Na_2O	...	2·22	1·36	0·82	—
K_2O	...	0·13	—	9·16	10·40

	I.	II.	III.	IV.
Li_2O ...	strong trace	—	—	—
H_2O {at 105° / red heat	0·07 / 3·67	2·25	6·77	5·42
	99·71			
O = Fl ...	0·02			
	99·69	100·08	100·17	99·52

A. H.

Gadolinite from Texas and Monazite from Canada (F. A. Genth *Amer. Journ. Sci.* (3) Vol. XXXVIII. p. 198).

Gadolinite from Burnett and Llano counties, Texas. Black; th splinters translucent with dark bottle-green colour; streak greenish-gre fracture conchoidal to splintery; sp. gr. 4·201 and 4·254; analy (Burnett Co.) given in Column I. below.

	I.		II.
SiO_2	22·87	SiO_2	0·91
Al_2O_3	0·28	ThO_2	12·60
Ce_2O_3 (ThO_2) ...	2·65	Ce_2O_3	24·80
$(Di, La)_2O_3$ ...	5·22	$(La, Di)_2O_3$ ...	26·41
$(Y, Er)_2O_3$ ...	44·35	$(Y, Er)_2O_3$ ...	4·76
BeO	9·24	Fe_2O_3	1·07
FeO	13·69		
MnO	0·22		
MgO	0·07	MgO	0·04
CaO	0·64	CaO	1·54
Na_2O	0·20	P_2O_5	26·86
K_2O	0·15		
Ignition ...	0·72	H_2O	0·78
	100·30		99·77

Monazite from Villeneuve Mica mine, Ottawa Co., Canada. Redd brown; indistinct cleavage; little or slightly waxy lustre; sp. gr. 5·28 analysis given in Column II.

A. H.

Sigterite, a new felspar.—C. Rammelsberg describes a new felsp which occurs in the form of grey granular particles associated w eudialyte and albite at Sigterö near Brevig. (*Neues Jahrb.*, 1890, V p. 71). It has the optical properties of a felspar, with twin-lamellati

n a flake parallel to the second cleavage the extinction-angle from the ge $P : M$ is + 16°; on a flake parallel to P the angle between the tinction-positions of adjacent lamellæ is 7° to 9°. Analyses give nearly e formula $Na_2Al_2Si_3O_{10}$; a much more basic constitution than that of the nown alkali-felspars. It may be regarded as a combination of a normal d a semi-silicate; or (doubling the formula) as one molecule of albite com- ned with three of an alkali-anorthite. It also corresponds to natrolite prived of its water, and the author suggests the possibility of the trolite of the zircon-syenite being derived by hydration from Sigterite.

A. H.

Secondary Amphibole and Pyroxene Minerals.—Whitman Cross has ently described a novel mode of occurrence of certain amphiboles and roxenes near Silver Cliff in Custer County, Colorado. (*Amer. Journ.* . (3) Vol. xxxix. p. 359; 1890.) The most interesting is a blue phibole having the a—axis of elasticity inclined at only 13°—15° to the -axis of crystallography, and giving the pleochroism-scheme: a = deep e, β = purple to violet, γ = pale yellow; absorption $a > \beta > \gamma$. No mplete analysis could be made, but the characters of the mineral bring ry near to riebeckite [see *Min. Mag.* Vol. viii. p. 167], and typical eckite with the characteristic intense absorption is found with it. The ineral occurs as an enlargement of original brown hornblende, or some- nes of pyroxene, and presents the usual crystallographic relation. In ilar association occur a green or colourless actinolite and a dark-brown phibole, perhaps barkevicite; and the author has no doubt of the ondary nature of these various amphibole minerals. As an alteration- duct of the blue amphibole occur little prisms of a pleochroic pyroxene, ing a = green, β = clear green, γ = yellow, and referred to ægirine.

To bring out the relations which exist among the various members of the phibole and pyroxene families, Cross adopts the treatment of the former ily proposed by Tschermak and advocated (in the same number of the *er. Journ. Sci.*) by G. H. Williams; the plane usually named the bodome ($\bar{1}01$) is taken as basal plane (001). It then appears that in the monoclinic amphiboles and pyroxenes the axes of greatest and least sticity, a and γ, lie respectively in the acute and obtuse angles between crystallographic axes a and c, and the angle between c and γ, reckoned ays in the same direction, is as follows:—

		°
Amphiboles :	Anthophyllite (rhombic)	0
	Glaucophane	5
	Tremolite, &c.	15
	Brown Hornblende	25
	Blue Amphibole of Silver Cliff ...	75
	Riebeckite	85
Pyroxenes :	Enstatite, &c. (rhombic)	0
	Spodumene	26
	Diopside, &c.	38
	Augite	45
	Augite	54
	Ægirine	87

Arfvedsonite will probably come near the blue amphibole as regards t orientation of its ellipsoid, but the discrimination between a and γ h appears to be open to doubt. Barkevicite, according to Rosenbusc observations, will be near glaucophane. A. H.

The Pyroxenites of Maryland.—G. H. Williams, continuing his stud on the intrusive rocks of Maryland, divides the non-felspathic rocks i the peridotites and the pyroxenites (*American Geologist*, July 189 The two groups are alike in being poor in alumina, but differ in th percentages of silica, which are typically 40 to 44, and 52 to 55 respective Further, in each group, the varying proportions of lime give rise to vari members of the pyroxene families. In the former group olivine occurs addition; in the latter pyroxenic minerals form the whole of the ro For this group the name Pyroxenite is proposed to be reserved, employment of this name by different authors in other senses be abandoned.

Of the Maryland pyroxenites one type consists of green diallage and pleochroic hypersthene; the former slightly in excess, and being, if a thing, slightly later in consolidation. An analysis of such a rock by J. Whitfield is given in column I.

	I.	II.	III.	IV.	V
SiO_2	50·80	52·55	54·53	51·80	55
TiO_2	—	0·14	—	0·13	—
Al_2O_3	3·40	2·71	1·93	2·21	0
Cr_2O_3	0·32	0·44	0·30	0·51	0
Fe_2O_3	1·39	1·27	1·70	1·29	3

	I.	II.	III.	IV.	V.
O	8·11	4·90	8·92	3·50	4·78
O	0·17	0·24	0·28	tr.	0·03
O	12·31	16·52	2·25	20·99	8·39
O	22·77	20·39	29·51	17·76	26·66
$_2$O	tr.	0·27	—	—	0·30
	tr.		—	—	—
O	0·52	1·09	1·14	0·65	0·38
$_5$	—	tr.	—	tr.	0·23
	0·24	—	—	—	—
	100·03	100·52	100·56	98·84	100·25
gr.	3·318	3·304	3·300	3·308	—

Another type is poorer in iron, and so lighter in weight and colour. It sists of reddish-brown bronzite and emerald-green diopside, the regate being usually even-grained, though a porphyritic development he bronzite is sometimes observable. An analysis of one example, by M. Chatard, is given in column II. It contains about three parts of the mbic pyroxene (III.) to one of the monoclinic (IV.). The figures show former mineral to be a typical bronzite, while the latter agrees with the me-diopside of the lherzolites, &c. Another example of a bronzite-psidc rock comes from near Webster in North Carolina. This is her more acid, and richer in magnesia, as is seen from the analysis (V.) E. A. Schneider. Williams proposes the name Websterite for all the ssive intrusives composed entirely of rhombic and monoclinic pyroxenes, i thus answering to Lherzolite among the peridotites. A. H.

Leucitophyres, &c., of the Laacher See District.—In a recent paper Martin gives a description of the leucitophyres and associated volcanic ks in the district west of the Laacher See, with a useful summary of the ensive literature dealing with these rocks. (*Zeitschr. d. deutsch. geol. s.* XLII. p. 181, 1890.) The leucitophyres, which occur in a number small outcrops, he divides into two groups: (i.) those without melanite, taining 53 or 54 *per cent.* of silica (Olbrück, Engelerkopf, Schillkpof, .), (ii.) melanite-bearing leucitophyres, with 48 or 49 *per cent.* of silica erlerkopf, Schorenberg, Rieden-Altenberg and the Hardt, Selberg). e former group have porphyritic crystals of nosean, more rarely sanidine, quently leucite, &c., in a very fine-grained ground-mass of nepheline and

sanidine with a smaller proportion of leucite and green augite. In th second group, which presents greater variety of characters, the porphyriti elements make up a larger part of the rock, and include nosean and leucit (the latter usually minute) with some sanidine, &c. In the rock of th Hardt the ground-mass consists mainly of small sanidines and nephelines in that of Schorenberg of nepheline and augite, with but little sanidine the Perlerkopf and Rieden-Altenberg rocks have but little proper ground mass, large sanidine crystals enclosing the other constituents. Leucit always occurs, but not in great quantity. The alleged perofskite seems t be only melanite. The author finds that the so-called leucite-tuffs of th district belong to the leucitophyres, and that the eruptions lasted into th time of the Löss formation, being, at least in part, among the younges products of vulcanicity in that region. [*Cf.* Busz's paper: abstract o p. 39 of this volume.]

The rock of the Selberg near Quiddelbach, some distance west of th above localities, is a phonolite containing olivine, though various writer have differed as to the presence of this mineral and also of the nepheline It is a dark-grey rock with greasy lustre, and encloses large porphyriti hornblendes. The ground-mass consists of little sanidine crystals wit fluxional arrangement and a smaller proportion of green augite. Th abundance of hornblende and the presence of plagioclase among th porphyritic constituents bring this rock near to the tephrites, while th olivine, which occurs irregularly in nests, links it with the basanites.

The rock of the Hannebacher Ley, with respect to which Rosenbusc seems to have fallen into some confusion, consists of augite, nepheline magnetite, melilite, and nosean, with only a little leucite, and perofskit It contains no felspar and is to be referred to the nephelinites. Th author further describes several basalts from different parts of the distric and he protests against the practice of distinguishing between "basalt and "basalt-lava" according to the compact or scoriaceous character the rock; a point of minor importance. A. H.

An Olivine-rock from Greenland.—The eighth part of the *Meddelels om Grönland*, which has recently appeared, contains an account of a olivine-rock collected by J. A. D. Jensen at Siorarsuit on the west coa (lat. 65°44′ N), described and analysed by K. Rördam (pp. 125-13 1889). Though less pure than the typical dunite of New Zealand, t rock consists mainly of olivine. It has a considerable extent, and i disintegrated substance forms a terrace 30 or 40 feet high, above whi in some places rise solid masses of the hard rock, succeeded at an elev

on of 120 feet by the granite, which forms the bulk of the island. The ck has a yellow-green colour, with a hardness of 6·5, and a mean ecific gravity 3·29. The powder is grey-green, with specific gravity 31. The accessory minerals are grammatite, magnesia-mica, and romite.

		I.	II.	III.	IV.
SiO_2	...	39·17	43·81	40·01	42·80
Al_2O_3	...	3·30	3·29	0·06	—
FeO	...	10·56	10·31	16·21	9·40
MgO	...	43·46	38·13	43·09	47·38
NiO	...	trace	trace	0·54	—
CaO	...	faint trace	trace	—	—
K_2O	...	0·55	0·13	—	—
Na_2O	...			—	—
H_2O	...	0·91	1·41	—	0·57
Foreign matter		1·59	2·37	—	—
		99·54	99·45	99·91	100·15

I. Olivine-rock, Siorarsuit (K. Rördam).
II. Ditto partly serpentinised, ditto. (K. Rördam.)
III. Olivine, Ameralikfjord, Greenland (C. T. Lappe).
IV. Dunite, Dun Mt., N. Z. (Reuter).

Eliminating the accessory minerals, the Siorarsuit olivine is found to ree aproximately with the formula $7·5\ Mg_2SiO_4 + Fe_2SiO_4$. A. H.

Serpentines and Serpentinous Rocks from Hungary. (*Ueb. Serpentine serpentinähnliche Gesteine aus der Fruška-Gora; Jahrb. d. k. ungar. ol. Anst.*, Vol. VIII. 1889). In this district M. Kispatic finds both true rpentines and serpentine-like rocks. The former are found to be derived om olivine-bearing rocks, the various stages of alteration being traceable specimens from different localities. The original rocks were of four ferent types. One consisted almost entirely of olivine (olivine-rock); the others a monoclinic and a rhombic pyroxene accompanied it, either parately (salite-peridotite and bronzite-peridotite) or both together erzolite). It is shown that the salite, as well as the bronzite, has given e to the bastite-pseudomorphs embedded in the dark serpentine ground-ss of most specimens. The 'serpentinähnlichen Gesteine' consist inly of flakes of antigorite with a scaly and often a lattice-like structure. ey are in great part derived from amphibolites, the gradual conversion

of the amphibole into antigorite being plainly seen. In other specimens the latter mineral is seen to be formed from salite, of which grains often remain. A. H.

Crystalline Rocks of Bornholm. For the excursion of the German Geological Society to Bornholm, E. Cohen and W. Deecke have written an account of the crystalline rocks of that island (*Ueber das krystallin Grundgebirge der Insel Bornholm*, Greifswald, 1889). The dominant rock is described as amphibole-biotite-granite, and consists of white, red or green felspars (microcline predominating), grey or colourless quartz, and abundant (microscopic) sphene. The basic constituents, which are not plentiful, are biotite and green hornblende: the latter has strong absorption parallel to β and γ, and gives an extinction-angle of 20° to 39°. There is also an amphibole-granite with biotite, in which the basic elements are more abundant, and this contains little or no sphene.

Besides veins of pegmatite, not sharply divided from the granite, there are numerous dykes of plagioclase-augite rocks. One type is an ophitic diabase, poor in olivine and with plentiful opaque iron-ores. The augite in this is sometimes pleochroic (β = reddish-yellow to light yellow, α and γ = greenish-grey to greyish-violet). Biotite is a constant accessory, and brown hornblende occurs in subordinate quantity: apatite-prisms are abundant. Another type is a non-ophitic olivine-diabase. The idiomorphic augite is light brown to violet-brown, rarely pleochroic; and the olivine forms large well-bounded crystals. Besides these types are olivine-diabases showing a gabbro-like habit, and others with a porphyritic structure described as 'olivine-diabase-porphyrites.' A. H.

Variations in Dyke-rocks. A. C. Lawson and F. T. Shutt have pointed out some interesting differences between the marginal and central portions of diabase dykes in the Rainy Lake region, near Lake Superior. These variations are (i.) structural—the passage from a very fine-textured diabase-porphyrite at the contact-walls, through ophitic diabase, to a granular gabbro-type in the middle; (ii.) mineralogical—from a quartzless rock at the contact to a quartzose one in the middle of the dyke; (iii.) chemical—from a more basic rock near the contact to a more acid near the middle. The textural and structural variation is ascribed to different rates of cooling under constant pressure, the chemical differences to selective crystallisation of the more basic minerals in the earlier stages of solidification, with a transference of the acid residue from the sides to the middle by the agency of included water. (*Amer. Assoc. Proc.*, Vol. XXXVIII.

A. H.

A Picrite from Maine.—G. P. Merrill describes a peridotite which forms a uniform mass of compact greenish-black aspect on Little Deer Island, Penobscot Bay, Maine (*Proc. U. S. National Museum*, 1888, p. 491). Olivine, completely serpentinised, makes up two-thirds of the mass in the usual rounded grains embedded in plates of augite. The other constituents are magnetite and chromite, plagioclase (now scarcely visible), apatite, sillimanite (?), and pyrite, with possibly some unindividualised base. These characters and the analysis, by L. H. Merrill, place the rock among the picrites. Sp. gr. = 2·83.

SiO_2	38·01
Al_2O_3	5·32
Fe_2O_3	6·70
FeO	4·92
MgO	23·29
CaO	4·11
Na_2O	4·15
K_2O	0·22
Ignition	10·60

The most interesting feature of the rock is the enlargement of the augite plates by a secondary growth of paler augite substance in crystalline continuity with the original plates. This new-formed augite extends as a ragged fringe into the serpentine pseudomorphs, or even forms delicate branches following fissures in the now serpentinised olivine-grains. This seems to be the first record of such a feature in augite, though the 'secondary enlargement' of hornblende, and of augite by hornblende, is well known. A. H.

Variolite of Homertshausen, Hesse.—R. Brauns describes an interesting case of 'diabase-glass' and variolite occurring as a marginal facies where two lava streams of diabase have come in contact with one another (*Zeitschr. d. deutsch. geol. Gesell.* Vol. XLI. p. 502; 1889). The associated slates belong to the boundary between Upper Devonian and Culm. The extreme margin of the diabase sheet consists of a zone not more than 6 mm. thick, of dark green, almost black, glass. The specific gravity varies from 2·425 to 2·585, and the composition is that given under Column I. Column II. shows the analysis calculated up to 100 without the water.

		I.	II.	III.
SiO_2	...	44·835	48·043	49·40
Al_2O_3	...	13·47	14·434	13·80
Fe_2O_3	...	11·79	12·633	—
FeO	...	4·49	4·811	18·17
MgO	...	11·605	12·435	10·67
CaO	...	4·795	5·137	—
Na_2O	...	2·34	2·507	—
H_2O	...	6·16	—	4·38
P_2O_5	...	trace	—	2·68
		99·485	100·000	99·10

For comparison, Column III. gives an analysis by Nordenskjöld of the Sordawalite from Finland; sp. gr. 2·58.

The zone next to the glass is somewhat variable. Sometimes it consists of a similar dark glass enclosing little white spherules, and this is followed by a zone 1½ cm. thick, of specific gravity 3·2, and of very compact appearance, with little crystals of olivine. In other places the little spherules in the glass become larger when traced inwards, the glass disappears, and is replaced by a yellow-brown paste, in which lie very numerous spherules as large as peas, giving a typical variolite. The variolite zone may be 10 cm. thick, more or less, and is often quite wanting.

From this zone inwards the rock developes into a fine-grained diabase, the outer part of which, for the thickness of 1 m. or more, is very compact. The diabase contains included fragments of limestone converted at the margin into coarsely granular marble.

The microscopic structure of the various types is fully described, and shows an interesting correspondence with the varieties of Sordawalite described by Löwinson-Lessing. [See *Min. Mag.* Vol. VIII. p. 164. The mode of occurrence is different from that of the Finland rock, which forms the margin of a dyke, but may be compared with the variolite of Mont Génèvre recently investigated by Messrs. Grenville Cole and Gregory.] A. H.

The Lamprophyres and Melaphyres of the Plauen Grund, near Dresden. By Bruno Doss. (*Tschermak's Min. u. Pet. Mittheilungen, XI. p. 17.*) In this paper, which is accompanied by a map and a plate of carefully executed microscopic drawings, the author gives an account of the mode of occurrence of certain veins or dykes cutting through the syenite which borders the left bank of the Weisseritz. Further north this syenite

overlaid by Upper Cretaceous and Quaternary deposits. The veins range from very trifling dimensions to dykes of 2 or 3 metres in breadth. They are referred by the author to Minette and Kersantite. They consist chiefly of biotite, orthoclase, greenish amphibole and chlorite. In addition to the orthoclase, microscopic examination shows that plagioclase and microperthite are present; also augite, pseudomorphs of hornblende, talc and serpentine, and pseudomorphs of quartz, &c. after olivine. Apatite, magnetite, titaniferous magnetite, sphene, rutile, zircon, spinel, hæmatite, limonite, epidote and carbonates also occur. Included fragments derived from the adjacent syenite are met with in these dykes. Schistose conditions of the lamphrophyres are also found, the schistose structure being considered by the author to be due either to parallel arrangement of mica-scales, sometimes at right angles, at others parallel to the sides of the dyke, or to mechanical stresses.

Some of these rocks are allied to augite-mica-syenite, and are occasionally rich in plagioclastic felspars; an analysis of one of them is given. The augite is mostly a colourless or pale-greenish malacolite. This, from dynamical action, sometimes passes into a fragmentary or crushed condition, at others it gives rise to a secondary development of biotite. Several modifications of hornblende occur in the minettes, including ragged, compact and acicular crystals, the latter being very minute and occurring either in felted aggregates within fissures in the rock, or as an alteration product in the pseudomorphs after olivine, which also occur in the minette. The hornblende has for the most part resulted from the alteration of augite, and this secondary development has frequently converted augite-minettes into hornblende-minettes.

The olivine-pseudomorphs are much more plentiful, and their boundaries are sharper near the contacts than in the central parts of the dykes, where they are sometimes represented only by rounded or amygdaloidal bodies. The olivine, once present in these rocks, is indeed only represented by pseudomorphs which consist of pilite, biotite, talc and magnetite, or finally of talc and magnetite. When this alteration is restricted to the outer border of the crystal, it is found, if the border consist of pilite, that the nuclear portion has been converted into chlorite. When the border consists of talc, then serpentine and carbonates have replaced the inner portion of the olivine crystal. Talc plays an important part in the replacement of the olivine. Nearly all the pseudomorphs after olivine have a coating of biotite. Among these pseudomorphs interpenetrating crossed twins are common, and, in places, are more plentiful than the simple crystals.

The sphene which occurs in the minettes is in part primary, in part secondary. The felspar occurring in these rocks is mostly granular, but in the Kersantites it is chiefly in lath-shaped crystals. Microperthite is of rare occurrence in the minettes. The twin lamellation of the plagioclase is partly due to mechanical stresses. The biotite in these rocks passes into chlorite and the chlorite into talc. Where this alteration into chlorite has taken place rutile is of frequent occurrence, but it seldom appears under other circumstances. In the Kersantites the chloritic alteration is accompanied by the development of anatase.

Calcite and quartz occur in pseudomorphs replacing augite, the latter substitution being at times a direct one, at others it takes place indirectly from chlorite. The quartz occurring in the minettes also has a bordering of augite. In the Kersantites, on the other hand, it carries growths of secondary quartz, with an optical orientation similar to that of the invested grain or crystal. The secondary quartz contains magnetite dust and crystallites. The lamprophyre dykes are accompanied by scarcely any trace of exomorphous contact metamorphism. Endomorphous metamorphism is generally, but not always present. The granular structure of the dykes gradually becomes finer in texture towards their margins.

The melaphyre of the Plauen Grund consists, as a rule, of a very finely crystalline dark grey or blackish groundmass, in which beautifully developed augite crystals (2 to 3 mm. in diameter) occur. These may become less numerous, and scales of biotite (1 to 2 mm. in diameter) may take their place. In either case porphyritic pseudomorphs after olivine are present, with here and there a felspar crystal. The groundmass is a finely granular admixture of felspar and mica, in which are scattered minute crystals or grains of hornblende. Amygdaloidal structure occurs in different parts of the veins, but is often totally absent.

Concerning the veins occurring at the tunnel opposite Königsmühle, numerous opinions have been formed, and several pages are devoted to an account of the views of successive observers, dating from the year 1771 up to the present time.

From a microscopic examination of many specimens, the author describes the rock as consisting of well-developed crystals of augite, long, rod-like crystals of hornblende and crystals or grains of completely altered olivine, lying in a finely granular groundmass, composed of lath-shaped plagioclase and mica-scales with hornblende prisms, grains of augite, apatite needles and magnetite, together with various alteration products, all of which are described in detail. The augite and hornblende of the groundmass are capable of mutual replacement. The nuclear portions

of the plagioclase crystals are very basic (anorthite), the borders are more acid (oligoclase).

The hornblendic mica-melaphyre is in no way connected with the lamprophyres of the Plauen Grund, and is distinguished from them by the presence of basaltic hornblende, of a basis, of an amygdaloidal structure, &c., but especially by the complete absence of any dynamo-metamorphic alteration. The mode of occurrence of the lamprophyres gives no further clue to their age than that they are younger than the syenite which they traverse and older than the overlying cretaceous deposits (Pläner). The illustrations given in the plate are chiefly of secondary growths and alterations, and of pseudomorphs after olivine, hornblende, &c. F. R.

Contributions to the Petrography of the Sandwich Islands. Edward S. Dana (*Am. J. Sci.* XXXVII., June 1889) describes the petrographical characters of a series of rocks from the Sandwich Islands, part of which were collected by Professor James D. Dana in 1887, and the remainder by the Rev. E. P. Baker, of Hilo, in 1888. The lavas of Mauna Loa fall into two main groups. The clinkstone-like basalts are in external aspect very like phonolites, and have specific gravities varying from 2·82 to 3·00. They contain little or no olivine. A characteristic feature is the beautiful radiating feather-like form assumed by the augite. The olivine basalts, on the other hand, are coarse grained and cellular with specific gravity ranging from 3·00 to 3·20. The olivine, which is abundant, occurs in very slender acicular crystals, elongated in the direction of the vertical axis.

The author gives a minute description of the delicate stalactites and stalagmites of Mauna Loa. They are found hanging from the roofs and rising from the floors of the long caverns left behind by the lava streams. Their peculiarity consists in the fact that the structure is coarsely crystalline throughout, so that it is not easy to say what could have been their mode of origin.

The lavas of Kilauea showed a general similarity to those of Mauna Loa. The more recent are dark coloured vesicular basalts containing little olivine. The augite occurs in the same feather-like forms as in many of the Mauna Loa lavas. Little or no glass was detected, even in specimens taken very near the glassy crust. The older lavas contain more olivine.

The lavas from the island of Maui differed widely from those of Mauna Loa and Kilauea. The most recent (from Haleakala) are dark coloured, scoriaceous and highly porphyritic with olivine and augite. The older

lavas differ still more widely, approaching in structure and composition to augite-andesites, though the silica percentage conforms to that of normal basalt. A specimen from the west of Maui is described as a felspathic andesite. It contains some olivine and a little biotite, but the main mass is made up of penetration Carlsbad twins of oligoclase.

Some of the specimens from Maui and also from Oahu were much altered, more so than any of the Hawaiian lavas, G. T. P.

Formation of Cordierite in Vitrified Sandstones.—The curious vitrified sandstone fragments enclosed in some basalts of Central Germany have long been known, and the occurrence of numerous minute hexagonal crystals in the glassy matter between the quartz grains has been recorded. These are very abundant, especially in the paler parts (poorer in iron) of the glass. In 1875 Prohaska studied the glassy borders surrounding enclosed fragments of slate and quartzite in the basalt of Kollnitz in the Lavant Valley, and found there, besides spinel, microscopic cordierite, in crystals about 0·16 mm. long by 0·07 to 0·12 mm. broad (*Sitz. Wien. Akad., math. naturw. Classe*, Vol. XCII., p. 26). Here the interior of the fragments was free from cordierite, which must evidently belong to the zone of fusion and intermixture only. F. Zirkel finds, however, that the still smaller crystals known in the 'vitrified sandstones' are also cordierite. The crystals are compound twins, having the form of a pseudo-hexagonal prism contained by the faces (110) and (010), terminated by (001). There are no pyramid forms, but sometimes the edges of the prism zone are truncated by (100) and (130). Longitudinal sections are thus four-sided. They extinguish straight, and give pleochroism, vibrations parallel and perpendicular to the vertical axis ($c = a$) giving respectively pale yellow and bluish tints. The pleochroism is increased by heating for 6 or 8 minutes on platinum foil. The refringence and birefringence of the mineral are low (like quartz). There is no evident cleavage. Cross-sections have a hexagonal outline, and show the characteristic division into six optical fields. The best examples were obtained from the Steinberg, near Breuna, in the Habichtswald (*Neues Jahrb.* 1891, Vol. I. p. 109). A. H.

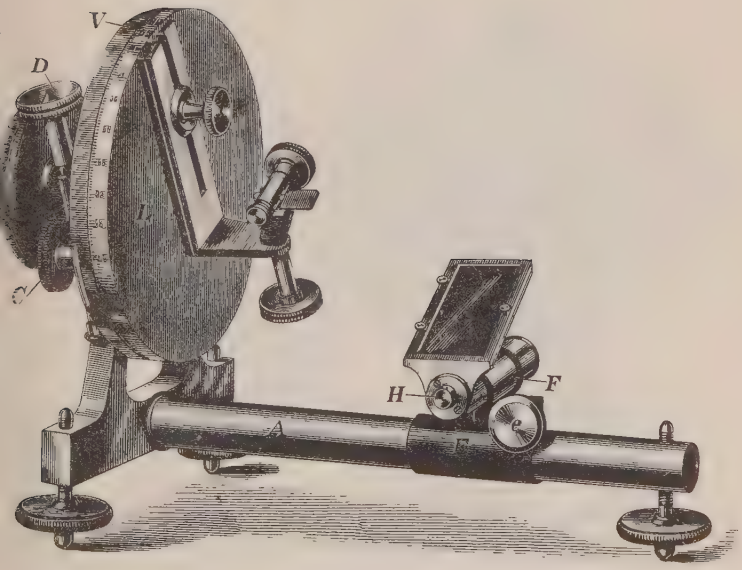

Fig. 1.

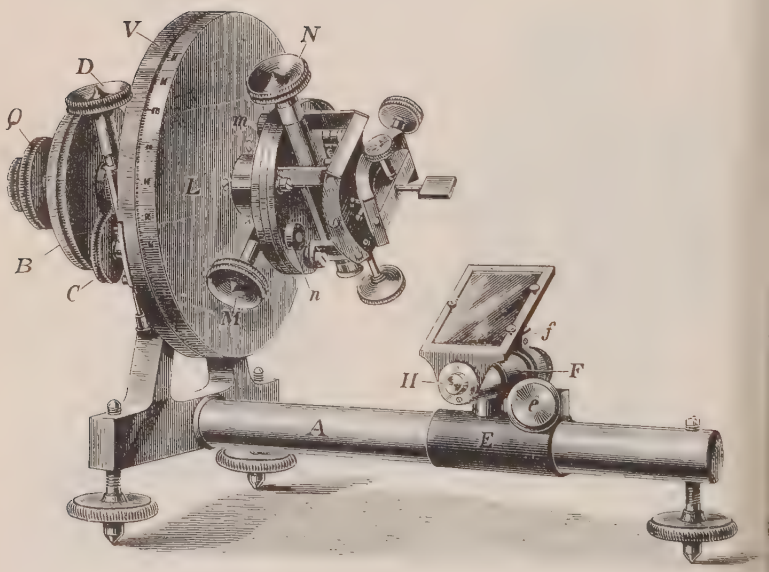

Fig. 2.

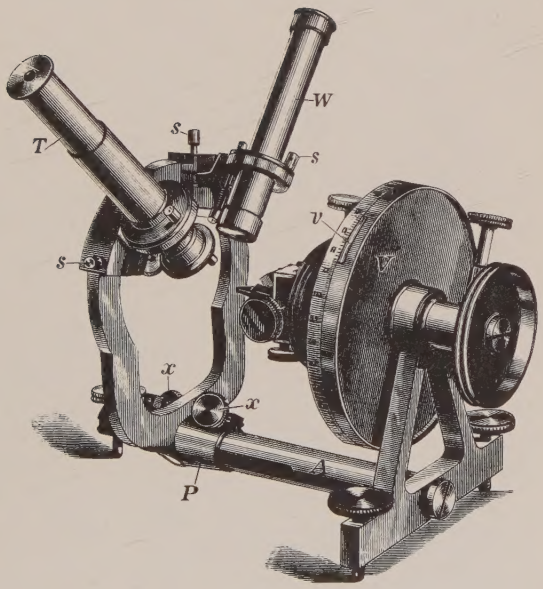

Fig. 3.

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ORIGINALLY PRINTED IN GREAT BRITAIN BY MESSRS. WILLIAMS AND STRAHAM, LONDON. REPRINTED OFFSET LITHO BY BIDDLES LTD., THE CITY PRESS, GUILDFORD, SURREY